

STUDENT TRAINING

CONTENTS

This section contains information to be covered in the Instructor's Certification Course.

1	QUALITIES OF AN INSTRUCTOR	2
2	METHODS OF INSTRUCTION	2
	2.1 INSTRUCTION	2
	2.2 PRINCIPLES OF LEARNING	3
	2.3 LEARNING IS AN ACTIVE PROCESS	3
	2.4 LEARNING ORIGINATES WITH SENSORY STIMULATION	3
	2.5 THERE ARE SEVERAL TYPES OF LEARNING	3
	2.6 THE SIX BASIC PRINCIPLES OF LEARNING	3
	2.7 FUNDAMENTAL ELEMENTS OF PARACHUTING INSTRUCTION	6
	2.8 FUNDAMENTAL PRINCIPLES OF INSTRUCTION	6
	2.9 INSTRUCTOR QUALIFICATIONS	7
	2.10 STAGES OF INSTRUCTION	8
	2.11 GUIDELINES FOR METHODS OF INSTRUCTION	9
3	FIRST JUMP COURSE	12
4	STUDENT PROGRESSION	28
	4.1 GENERAL PROCEDURES	28
	4.2 LEVELS OF PROGRESSION	28
5	FREEFALL PROGRESSION	31
6	HAND-DEPLOYED PILOT CHUTE CONVERSION	47
7	TRANSITION TO HIGH PERFORMANCE PARACHUTES	48
	(Incorporating the Canopy Pilot's Handbook by Bryan Burke)	50

1 QUALITIES OF AN INSTRUCTOR

The parachuting with which we are concerned is that which people indulge in for enjoyment. For this reason it is called sport parachuting and a good instructor must do as little as possible to interfere with the enjoyment of the sport.

He must therefore be **approachable**.

The primary concern of all parachuting must always be safety. It almost goes without saying therefore that a good instructor must be **safety-conscious**.

Safety cannot be achieved without supervision and a willingness on the part of all concerned to abide by the rules; this of course, requires discipline. In order to maintain discipline an instructor must be **firm and unbiased**.

A good instructor, who is responsible for the safety of those in his care should therefore be firm but not overbearing. He must accept only that response and compliance which will ensure that parachuting can be conducted safely. He will, as in other activities, achieve the best results by **setting a good example**.

Freefall parachuting is more than a skill. It requires a cool head, concentration and judgement, as well as body control and agility. In the early stages of his freefall progression a novice is likely to be apprehensive. The instructor can help him overcome this by instilling confidence through his own confident attitude. However, there is only one thing worse in this regard than lack of confidence, and that is over-confidence. The latter leads to the acceptance of risks that will inevitably lead to accidents. An over-confident parachutist is a menace to himself and to others; he should be closely supervised and, if necessary, disciplined.

Parachuting can be a complex matter, and the supervision thereof more so. The instructor carries a great deal of responsibility and has much to think about. **He cannot, for example, instruct others if his mind is on his own skydiving.** When he is instructing he must concentrate wholly on the task at hand. In order to ensure that nothing is overlooked, he must be **systematic**.

When conditions are right for parachuting, there is a tendency for people to become impatient. Haste leads to danger because sooner or later something important will be overlooked. "If you are in a hurry you are in danger", is a good parachuting motto. The good instructor therefore, must be **alert but unhurried**.

Parachuting is not always straightforward. Most parachutists experience problems at some time during their progression. Most of these problems are minor, but at the time they are a cause of concern. Often the novice cannot determine the cause of his problems, and it is up to the instructor to spot the cause and explain how it can be overcome. In order to do this a good instructor must be **observant**.

There is no substitute for practical experience. The instructor who is highly experienced is better than the less experienced one. He has personally met and overcome many of the problems that from time to time will confront his pupils. But no instructor, however expert, will experience all the problems of others. He will, however, be called upon to give advice and in order to do so, he must understand parachuting in all its aspects; this can only be achieved through intensive and on-going study and intelligent discussion. To this end he must have an **inquiring mind**.

Honesty. Student parachutists may be intelligent human beings and will often quickly see through an instructor who lies to them. If you cannot answer a student's question, tell him that you will find the answer and tell him at the earliest opportunity.

2 METHODS OF INSTRUCTION

2.1 INSTRUCTION

The performance and even the survival of student parachutists depends directly upon the effectiveness of the instruction that they receive during their training period. The effectiveness of this instruction is determined by the instructor. The fact that a man is a competent skydiver does not guarantee his ability to administer effective instruction. In order to teach others, he must also have a

sound working knowledge of the best methods and procedures for imparting his store of parachuting knowledge to his students.

2.2 PRINCIPLES OF LEARNING

There are certain general principles which parachuting instructors must know and be able to apply in teaching. These principles are the basis for instructional methods and techniques.

2.3 LEARNING IS AN ACTIVE PROCESS

Learning can be defined as the process of acquiring new knowledge, skills, techniques and appreciation that will enable the individual to do something that he has not done before. The emphasis is placed upon doing. Learning is essentially an active process; it is not passive absorption. Students must be given purposeful, worthwhile work to do; they must be kept active both mentally and physically.

2.4 LEARNING ORIGINATES WITH SENSORY STIMULATION

Learning can also be defined as the change that takes place in the individual's behaviour as the result of his mental and physical responses to stimuli. The five senses are the channels through which the student is stimulated. Through these senses - sight, hearing, touch, taste and smell - he makes contacts with things around him.

As a result of these contacts, he makes responses that lead to the acquiring of new knowledge, habits and attitudes. It is the instructor's responsibility to provide learning situations which make the maximum use of the senses and which produce the desired responses.

Lessons, which appeal to the greatest number of senses, are the most effective. This is one reason why training aids and demonstration should be used at every available opportunity.

2.5 THERE ARE SEVERAL TYPES OF LEARNING

In learning, the student may gain knowledge, abilities or emotionalised controls.

- **Knowledge** (or "understanding") is the acquisition of ideas, concepts, meanings, facts and principles.

- **Abilities** (both mental and physical) include habits, skills, and the ability to adapt and apply knowledge to the solution of problems.

- **Emotionalised controls** include the attitudes, appreciations, interests, ideas, and habits of conduct that are necessary to give value to learning.

The instructor must be constantly aware of these several facets of learning which are integral in the training of a sport parachutist.

2.6 THE SIX BASIC PRINCIPLES OF LEARNING

These describe the conditions under which learning takes place. They serve as guides to the instructor in his selection and use of teaching methods, devices and techniques. The principles are mutually supporting and all apply to every instructional situation.

The principles are:

- Motivation
- Objective
- Doing
- Realism
- Background
- Appreciation

2.6.1 Motivation

Learning can be effected only when the student is properly motivated, when he is mentally and physically ready to learn because he knows the reason why he should learn.

Motivation is the conscious effort of the instructor to establish student motives that lead to sustained effort toward the learning goal. Motives create a desire to learn.

Motivation is the very heart of the learning process and one of the instructor's most fundamental problems since without motivation, students learn very little. To help motivate his students, the Instructor should show a need, that is, impress upon the student the applicability of the material under study to his upcoming venture into parachuting.

The instructor should guide each student in developing an intent to learn, by instilling in the students the realisation that they are responsible for learning the material that is presented.

The instructor must maintain student interest to assure alert attention to the presentation. He may do this through personal force and enthusiasm, illustrations, and, in limited form, personal experiences ("jump stories" which illustrate the point under discussion).

Early success is a strong enforcement to further learning and is a very flexible aid in instruction. These successes may range from a simple "very good PLF" commendation from the instructor in the presence of other students, to a "Student of the Month" plaque which some clubs award. For the normal person, these achievements bring a certain amount of pleasure and satisfaction and thereby stimulate him to greater activity.

The instructor should make a point to give recognition and credit. These are strong incentives to learning, and students desire, and have a right to expect, credit for work well done. Instructors must mention the good points of students' work and not dwell entirely on their mistakes. Start with favourable comments, then lead into suggestions for further improvement.

Avoid feelings and emotional responses that can interfere with learning. Students who are angry, resentful, embarrassed, frightened, or otherwise emotionally upset, think about the source of their disturbance rather than the subject being taught.

2.6.2 Objective

Learning is more efficient when the student knows exactly what he is to learn and what is expected of him.

Learning is more efficient when the student knows the objectives toward which he may direct his learning efforts. He should know the objective of each lesson and see how the lesson fits into the overall programme of instruction. The lesson objectives and the standards of subsequent performance expected of each student must be emphasised in the introduction to each lesson.

2.6.3 Doing

The most efficient way of learning is by doing. Good instruction takes advantage of the fact that we learn more of the things we do than of those we see or hear.

To apply this principle to the learning of informal phases of a subject the instructor must provide opportunities for student activity - thinking, talking, writing, and problem solving. Verbal directives, demonstration, and various other forms of instruction help the learning process; but practice, repeated under supervision until proficiency is attained, is essential to complete learning.

In sport parachute training, opportunities for taking full advantage of the principle of doing are many. PLF practice, supervised packing, **practising emergency procedures in a suspended harness** and practising exits from a mock-up of the aircraft are a few common examples of opportunities to apply this principle.

THE MOST EFFICIENT WAY OF LEARNING IS BY DOING.

2.6.4 Realism

The more realistic the learning situation, the more efficient the learning.

This principle requires constant consideration by the instructor to insure that learning activities in training reasonably approximate the situations of actual practice. Each lesson, or main point of a lesson, should be subjected to the test of these questions:

Is this the way the parachutist must behave in a real situation?

The instructor should consider whether or not there might be other factors than those encountered in the training situation that will be present in an actual aerial situation.

For instance students learning malfunction procedures on an indoor suspended harness would find the situation unrealistic, due to the absence of noise, stress and the relative wind.

Is my presentation realistic as far as the level of the class is concerned?

Instruction beyond student comprehension is unrealistic; however, relatively difficult subject matter can be presented to classes of different levels if it is adapted to their specific needs and is explained in clear language. For instance, in teaching a class of students techniques of basic freefall manoeuvres, the technical aspects of why this or that will aid or hinder a turn because of effects of centre of pressure, centre of gravity, angular momentum, etc., would tend to create a thicket of complexities which would confuse the average parachutist.

Therefore the instructor will want to translate these relationships into terms of "what this means to you is that you'll be able to execute a flat turn to your right by assuming this position". Keep it **Safe**, Keep it **Simple**, Keep it **Short**.

THE MORE REALISTIC THE LEARNING SITUATION, THE MORE EFFICIENT THE LEARNING.

2.6.5 Background

A student acquires learning only by building upon what he already knows.

Learning is based on, and organised around, previous experience. New experiences are interpreted on the basis of past experiences. Since the past experience of all students is not the same, they will not attach exactly the same meaning to an explanation.

Instructors must select and present illustrations carefully so that all students will get the desired meanings. In early stages of parachute training, instructors must draw on common experiences of two-dimensional ground life for illustrations, but for more advanced training, more illustrations may be drawn from the parachutist's previous aerial experience.

Instructors may apply this principle in the introduction to a lesson by reviewing previous instruction. This aids the student in associating techniques. What has been learned in previous lessons makes up the student's background, a foundation for subsequent teaching.

Instructors should take into consideration the state of training of students and make reference to lessons already learned, and use these lessons as a foundation for their presentations.

2.6.6 Appreciation

The learning process is not complete until the student has acquired the attitudes, appreciations, interests, ideals, and habits of conduct that cause him to apply his knowledge in the optimum fashion to solve the myriad of problems which he may encounter as a parachutist.

Learning is complete only when the student has acquired the attitudes, appreciations, interests, ideals, and habits of conduct that will enable him to apply correctly the things learned.

This statement is of such importance in sport parachute training that it should be considered a fundamental principle for the guidance of instructors. The parachute instructor must not only concern himself with the teaching of skills and information which contribute directly to the lesson; he must also be alert to the development of correct appreciation and attitudes which will enable the student parachutist to most effectively apply his knowledge to actual parachuting situations.

The instructor's real ultimate goal is to train individuals not merely to teach subject matter. The calm, analytical attitude that a parachutist must develop is an essential responsibility of the instructor to instill in his students, since a parachutist who is incapacitated by panic cannot be expected to adequately deal with an emergency situation, even if he has been "taught" how.

To apply this principle in his teaching, the instructor must be alert to every facet of his student's development. He must recognise that his students learn many things from his instruction above and beyond the subject matter presented.

The instructor must set a good example; he must employ a positive attitude toward his instruction. Students are quick to pattern their reactions after the attitudes of the instructor.

The instructor must be cautious to refrain from making incidental remarks and voicing personal opinions that do not contribute to the desired student attitude.

The instructor should set an example for his students that they may safely follow.

2.7 FUNDAMENTAL ELEMENTS OF PARACHUTING INSTRUCTION

The fundamental elements of an instructional situation are:

- The Student
- The Instructor
- The Teaching Process, which consists of the five stages of instruction:
 - Preparation
 - Presentation
 - Explanation/Demonstration
 - Application
 - Examination
- Review and/or Critique

To be successful, the instructor must understand his students and the way in which they learn. As far as possible the instructor should know his students as individuals, appreciate their learning problems, and make every effort to help each student learn.

Instructors must see the course of instruction from the point of view of the learner and plan accordingly.

2.8 FUNDAMENTAL PRINCIPLES OF INSTRUCTION

There are certain fundamental principles followed by effective instructors.

- Never bluff to cover lack of knowledge. Instructors must know their subjects thoroughly; but even then, questions may arise to which they do not know the answers. If you do not know the answer, admit it; then find the correct answer and give it to the class as soon as possible.
- Never use profanity or obscenity in instruction. If you do, you risk loss of dignity and class respect.
- Never use sarcasm or ridicule. Since students are helpless to retort, they become resentful, and therefore resistant to learning.

- Never talk down to a class. Make your class feel that you consider yourself fortunate to have acquired the experience and knowledge that you wish to share with your fellow parachutists.
- Never lose patience. Slowness or inability to grasp a concept may mean that the instructor has failed to teach, not that the student has failed to learn.
- Remember that learning is acquired to ensure safety in parachuting. Use every opportunity to impress upon students the practical aerial importance of what they are learning.

2.9 INSTRUCTOR QUALIFICATIONS

There are certain qualifications that an instructor must possess to do an effective job of teaching.

- Knowledge of the subject

It is obvious that the instructor must know his subject, if he is to teach it others. He should know more about sport parachuting than he will ever have time to teach and, certainly, should be prepared to answer virtually any question on the subject.

- Knowledge of techniques of instruction

Knowledge of how to instruct is a definite prerequisite to good instruction, and is the reason for this article.

- Personality of the instructor

A good personality is considered essential to success in all fields of endeavour in which people have to work together and become closely associated.

Personality can be defined as the sum total of all those things about an individual to which other people respond, either favourably or unfavourably.

A "good" personality - one that elicits a favourable response - is not some mysterious inbred quality. It can be developed by concentrating upon and improving specific features of the personality.

Each instructor should observe other instructors whenever he can, and weigh their personality characteristics against his own.

He should then strive to develop in himself those characteristics that contribute to successful teaching, and to avoid those traits that interfere with effective instruction.

- Leadership

Instructors who are good leaders can develop proper attitudes and appreciations in their students, as well as teaching the basic information of the course. The instructor must have leadership ability if he is to maintain control of the class and keep it moving efficiently. Classes must be managed before they can be taught.

- Professional Bearing

The parachuting instructor must have genuine and sincere interest in students and their success, in sport parachuting and effective methods of teaching it, and in the specific training course that he is conducting.

To succeed, the instructor must have a sympathetic understanding of his student's problem and be fair in dealing with each individual.

The instructor who has the proper professional attitude will continually add to his store of knowledge and skills in his subject and make continual effort to improve his teaching ability.

Everything the instructor says and does during classes and on the DZ, as well as the manner in which he says and does things, reflects his attitude toward his students, his subject, and the training programme.

His attitudes have a tremendous influence upon student attitudes and morale, because students tend to adopt both the attitude of the instructor and his point of view toward the subject and the training.

2.10 STAGES OF INSTRUCTION

The stages of instruction serve as a checklist for the instructor in choosing teaching procedures. Whenever practical, this applies to all five stages to each lesson to be presented.

In some lessons, various stages are combined; for example;

In many practical exercises the application and examination stages are combined. In controlled practice, when material is presented step-by-step, the presentation and application stages are combined.

Flexibility is the key to successful use of the stages of instruction. The instructor should use them as a guide; they are not intended to cause instruction to become artificial or stereotyped. However, the instructor must study every instructional situation for opportunities to use student stages. He must strive for the complete teaching process in which he can plan, tell, show, do, check and review and/or give critique.

IF THE STUDENT FAILED TO LEARN, THE INSTRUCTOR MAY HAVE FAILED TO TEACH.

- Preparation

Careful planning is the first step in efficient training.

The instructor must analyse the specific procedures, skills, and information to be taught.

He must organise his presentation so that the basic ideas are adapted to the student's background and needs so that the lessons are aimed at achieving specific objectives.

He must present the lesson in the manner that will best facilitate learning; the objective of the lesson will determine the methods to be used.

He should proceed from the simple to the complex; from the known to the unknown.

Careful preliminary analysis, correct solution of all instructional problems, and repeated rehearsal and review of procedures and materials will help to insure maximum student learning in the minimum amount of time.

Mastery of the subject is only the first step in instructor preparation. The instructor must also determine how to arouse the student's desire to learn and how to present the subject materials so that each member of the class learns all essential procedures and ideas.

- Presentation.

Actual teaching begins with the presentation stage. (elementary school teachers call this the "show and tell" stage). This stage begins with the introduction, in which the instructor informs the students what he expects them to learn during the class, why they are learning this particular material, and what level of proficiency they are expected to attain.

- Explanation.

Following the introduction, the explanation presents new concepts to the students. This may be accomplished by lecture, conference or discussion, all of which lead to comparisons and contrasts in terms of what the student understands. The instructor must remember that telling, through lecture and

conference, is limited in its appeal to the sense of hearing. A combination of techniques utilising several senses - such as sight, touch, and hearing - results in faster, more efficient learning and should be employed whenever possible.

Another important method for teaching (presenting) certain parachuting techniques (such as emergency procedures, exits and packing) is demonstration. This is a particularly useful method for presenting the student's initial instruction in the subject. Use of another experienced parachutist as a demonstrator allows the instructor to concentrate on his narrative and respond more closely to his class.

- Application

In this stage, the students are given the opportunity to do, to apply the principle and procedures learned during the presentation.

Efficient use of application periods will often give students a firm grasp of a difficult subject, such as packing. Application periods must always be supervised to insure that students follow correct procedures.

- Examination

In this stage, the instructor checks on the student's mastery of the subject taught. Instructors can ascertain that students have mastered the essentials only by checking their ability without assistance.

- Review and/or Critique

This is the final stage of instruction and always follows the application and the examination. Here the instructor reviews the knowledge, skills, techniques, and procedures learned by the students during the instructional period, taking care to clarify any phases of the instruction that are not completely understood. The term critique is usually restricted to the review given after an examination or applicable exercise.

2.11 GUIDELINES FOR METHODS OF INSTRUCTION

Teaching (instructing) is an art. A good instructor is not necessarily one that has great knowledge but one who can convey that knowledge effectively. The following are guidelines to assist an instructor:

- Setting

Establish control of your students from the start. An image of professionalism does more to put your students at ease than anything else. At the same time be approachable and encourage questions. A course without questions from students is a course that is probably not succeeding.

- Motivate

Before each lesson motivate why you are doing the lesson and why they need to know it. Motivation keeps them aware.

- Systematic

Do your course in chronological order where possible. Make it possible for them to see progression. Each lesson should follow from the previous one.

- What concerns them

Put their minds at rest whenever you can. Try and put yourself in their shoes. What would be particularly concerning them with the lesson you are giving?

- Emphasis on doing

80% of knowledge is retained through doing. The course must be as realistic as possible i.e. use as many aids as possible. Try to emulate on the ground what would happen in the air. Keep them physically active.

- Don't bluff

If you don't know, find out, but don't ever guess as this detracts from your professionalism.

- Reinforce

In order to show progression and systematic instruction it is necessary to tie your next lesson to the previous one. e.g. "The last lesson we did this ... now we go on to the next stage which is this".

- Work cards

Trainee instructors will find it easier to give a course using small work cards that are laid out in point form.

- Intervals

If a theory lesson lasts longer than 25 minutes, have a short break afterwards. The concentration span of the average person drops dramatically after 25 minutes of non-stop lecturing.

- Questioning

Ask questions with a specific objective in mind. Don't word your questions in such a way that the answer will be innocuous. Spread the questioning among the group don't just pick on your "bright" pupil. Pose the question; wait a few seconds then choose someone to answer. This way everyone ponders the question and nobody "switches off".

- Eye contact

Keep eye contact with all your students; don't concentrate on one student while you talk. Make sure your students have their backs to the sun. It's uncomfortable for you but it doesn't detract from their concentration.

- Stories (anecdotes/jokes)

A good instructor should relieve tension at appropriate places by telling a well-timed anecdote to do with skydiving. This also gives the student an appreciation of the sport and its facets. This should not be overdone.

- Practical lesson

If you are busy with reserve drills or landings, for example, don't leave the majority idle while you deal with one person. Everybody should be participating or kept busy when you give an individual attention.

- Perfection

Don't settle for less than perfect. If necessary take the student aside and reinforce.

- Blackboard work

Print - it's easier to read. Preferably do your board work before commencing the lesson. Don't talk with your back to student. Use wall charts instead of the board where possible.

Keep your explanations simple.

NB: Don't get involved in confusing explanations that are not necessary to the students' needs.

- Post-jump critique

Effective instruction is not complete without follow-through and reinforcement. Go through the students' jumps with them as soon after the jump as possible and point out their weaknesses and strengths.

- The sandwich method of discipline

It is often possible to discipline/critique in such a way that a student never returns or is disheartened. Use encouragement, praise or reason to start with. Critique or criticize (chastise) in the middle and end off with more praise, reasoning and encouragement. This method is particularly effective in encouraging progression without resentment.

Don't wear dark glasses inside a lecture room. You lose contact with students.

3 FIRST-JUMP COURSE

OBJECTIVE

To impart sufficient knowledge to enable students to make safe static-line descents and to prepare them for progression to freefall.

It is intended that the student can perform the following without hesitation, executing fluent drills, before he is permitted to make his first jump:

- Manifest himself and pay for the jump.
- Fit the parachute correctly.
- Board the aircraft in the correct manner.
- Move in the aircraft correctly with due care for his equipment and reserve handle.
- Check his equipment prior to exiting.
- Exit correctly in the stable, arched position.
- Count out loud at the correct speed.
- Check his main canopy deployment in the prescribed manner and, if necessary, carry out the correct reserve drill confidently and timeously.
- Control his parachute correctly.
- Land his parachute correctly.
- Know what to do in case of a hazardous landing or dragging.
- Gather his parachute up properly and carry all his equipment back to the packing area.
- Take due care when moving on the airfield particularly when crossing runways.
- Report back to the Jumpmaster for a debriefing and to get his next jump authorised in his logbook.

EQUIPMENT

The following items of equipment (training aids) are required to efficiently conduct a first-jump training course.

- Lecture room facilities with chalkboard and, preferably, video.
- Photographs or diagrams of the parachutes being used on the course.
- Aerial photograph of the drop zone.
- Log book.
- PANAM membership forms.
- Parachute equipment of the type being used and all peripheral equipment (jumpsuits, helmets, altimeters, hand batons, radios, etc.).
- Training posters (flip charts) to show types of malfunction and to show a good canopy.
- Suspended training harness facilities.
- Aircraft from which first jump will be made.

PRESENTATION

This course consists of the following lectures:

- Introduction and documentation
- Equipment
- Aircraft drills
- The Exit, arch and count (including body position)
- Canopy control
- Malfunction theory
- Reserve drills
- Landing (for main and reserve parachutes)
- Hazardous landings
- Post-landing procedures
- Revision/test and consolidation

REVISION

Each lesson's content should be revised by the instructor, preferably with the active participation of the students.

TEST AND CONSOLIDATION

At the end of each lesson the instructor must evaluate his students in order to complete the learning process. This is best done by questioning pupils verbally but can be assisted at the end of the course by a standard written test. This test must be objective and the questions be well structured.

PERIOD 1**INTRODUCTION AND DOCUMENTATION****OBJECTIVE**

To introduce yourself to the students and to give them some background on sport parachuting and to outline what the sport holds for them as they progress. Also, to fully brief students on the "operation of jumping", i.e. NCAA, PANAM, Standard Operating Procedures of the club and the PANAM MOPs.

EQUIPMENT

- Chalkboard
- Flip charts
- PANAM Manual of Procedures

PRESENTATION**Safety**

How and why accidents occur. Explain the necessity for discipline at all times and being able to take discipline when it is handed out. Explain that a student is NOT acceptable for sport parachuting if he cannot accept in good grace the discipline he will face on the course. Point out that jumping is hazardous if carelessness creeps in. However, constant care and attention will make it safe.

Fear in Parachuting

Explain to the student that he will be scared on his first jump. This is natural. Emphasise that the real challenge is to overcome this fear and not to just make a parachute jump. Impress on him that he must decide now not to give up until he has made at least one freefall. Point out to him that 8 out of 10 people give up after their first jump, possibly because they do not determine at the beginning to give it a good go. Regular jumping is required to maintain progress and subdue fear.

Operations at the club

Explain the method of operation to include:

- Jump costs and manifesting
- Drawing equipment and returning it to the packers or racks after jumping
- Airfield procedure - particularly crossing of runways
- Club rules such as smoking in the packing and refuelling areas
- Logbooks to be filled in by Jumpmaster after each jump
- Application of the PANAM MOPs
- Currency
- Progression
- Reciprocity

Divisions of sport parachuting

Outline the various disciplines within the sport. Run through what is involved in each. Go on to explain how the student progresses through the different levels.

REVISION

Summarise the lecture content and outline the format that the rest of the course is to take.

TEST AND CONSOLIDATION

Students must be advised that for the duration of the course they are expected to attain a proficiency level necessary for a first jump - failing which they may not jump.

PERIOD 2**EQUIPMENT****OBJECTIVE**

- To teach the student to check his equipment before putting it on, and to be able to adjust and fit it correctly leading to a safe and comfortable jump.
- To demonstrate effectively the deployment of both the main and the reserve parachute.
- During this period you can teach the student to respect equipment with consequent longer life of club equipment. You can also ensure that he always presents himself at the aircraft correctly kitted up with minimum interruption of the smooth flow of flights and minimum work for Jumpmasters.

EQUIPMENT

- Parachute equipment of the type to be used on the first jump.
- A chalkboard and a photograph of the appropriate equipment to illustrate the situation of the slider, toggles, etc. while under canopy.
- All peripheral equipment.

PRESENTATION

Explain the component parts and their purpose, to include:

- Risers
- Three-ring release system
- Chest strap
- Leg straps
- Reserve ripcord handle
- Cut-away handle
- Static line
- Reserve Static Line (RSL)
- Peripheral equipment

Fitting

Explain and demonstrate the fitting procedure to include the following:

- Leg straps must be TIGHT (without cutting off circulation) - it is the only adjustment to make the harness fit.
- Chest strap to fit width of chest.
- No loose webbing to be flapping around.

Practice the student in fitting the parachute.

Demonstrate effectively the deployment of the main parachute. Make reference to reserve parachute (using appropriate aids and/or assisted by a real demonstration).

- Main parachute
 - Static-line hook and static line
 - Pack closure
 - Line stowage
 - Bag closure
 - Canopy stowage and deployment
 - Slider
 - Risers
 - Steering toggles
 - Cutaway system

- Reserve
 - Cutaway system
 - Reserve ripcord handle
 - Pilot chute
 - Risers
 - Steering toggles
- Field packing (give an effective demonstration)

Care of Equipment

Explain to the student the factors that can damage a parachute, direct heat (e.g. cigarettes) and sunlight. The student should be told that the only three places where equipment may be found are:
Back, Pack and Rack

- On his back (i.e. in use).
- Being packed
- In the equipment store (on the racks).

Parachutes should be packed as soon as possible and should never be left in the sun, packed or unpacked.

REVISION

Revise the lecture content.

TEST AND CONSOLIDATION

Practical evaluation can be done by getting all the students to kit up in pairs - ensuring that every individual goes through the drills of kitting up.

PERIOD 3**AIRCRAFT DRILLS****OBJECTIVE**

To teach the student:

- To board the aircraft safely
- To move in the aircraft without endangering himself, or the aircraft
- To check his equipment before exit
- To make him aware of aircraft emergency procedures.

EQUIPMENT

Aircraft from which jumps will be made. Parachute system.

PRESENTATION

WARN THE STUDENTS THAT THEY MUST ALWAYS PROCEED AROUND THE BACK OF THE AIRCRAFT, NEVER IN FRONT. IF THE AIRCRAFT IS MOVING THEY MUST STAND STILL UNTIL IT STOPS.

- Students must be made aware that under no circumstances do they board an aircraft without being properly checked out by a Jumpmaster/instructor.
- How to climb in and move safely in the aircraft.
- At 1000ft give command "CHECK EQUIPMENT" and check static-line attachment.
- The jumper will check himself as follows, calling out each item as he checks:
 - Helmet! (fastened)
 - Three-ring releases! (intact, in place)
 - Chest strap! (fastened)
 - Handles! (reserve and cutaway, in place, accessible)
 - Leg-straps! (fastened tight)
 - Static-line! (hooked up)
- On completion of check, the student will give the instructor the "THUMBS UP" sign. Instructor will have visually checked students at the same time ensuring that the static line is not misrouted.
- Run in, Standby, Climb out and exit procedures as per club policy.

Aircraft emergency drills

Brief the following procedures:

- Engine failure (above 1000ft AGL): Inform the pilot you are dispatching the student. Despatch static-line jumpers as quickly as possible.
- Emergency landing (below 1000ft AGL): Give command "PREPARE FOR EMERGENCY LANDING".
- Canopy entanglement with aircraft.
- Hung up parachutist.

REVISION

Summarise the lecture's content with physical demonstrations given for each step.

TEST AND CONSOLIDATION

This is one of the most critical periods from a safety standpoint. Again, it is one that is usually rushed through and can have serious consequences even later in a jumper's career. Remember that students who know what to do and when to do it make the instructor's life easier.

Ensure that each student has actively participated in the aircraft drills. Evaluation can be done practically as well as by questioning.

PERIOD 4**EXIT, ARCH AND COUNT****OBJECTIVE**

To teach the student the basic body position, and the theory of the arch and the count.

EQUIPMENT

Chalkboard (minimum)

Optional:

- Photograph illustrating student arch
- Mannequin to show effects of different body positions
- Video

PRESENTATION

Take the class to the chalkboard and explain the theory of stability and how you fall stable in spread position. Deal with the following specific points:

- A. Theory of spread position
- B. Importance of arching
- C. Relative wind - especially on exit
- D. Position in relation to malfunction

Demonstrate, practice and critique the students on the correct body position.

Now add in the count as follows:

Spread and count "ARCH THOUSAND" at the same time. (Any hesitation after "GO" may mean that as he starts to fall he may not count at all).

Continue counting up to 5000.

After 5000 he must count "CHECK" and look and point up to check his parachute. (Maintaining the arch position from the waist down)

Counting must be LOUD and WITHOUT HESITATION.

ARCH THOUSAND

2000

3000

4000

5000

CHECK

Practice and critique the students to a high level of proficiency.

N.B. This phase of the course should be conducted with whatever training aids are necessary to ensure a competent and safe arch.

REVISION

Summarise the lecture content stressing the importance of the student arch and the count in the exit.

TEST AND CONSOLIDATION

Practical evaluation is essential. Each student must have demonstrated his ability to arch correctly on the ground. At the conclusion of this period the student must be able to adopt, INSTINCTIVELY, the correct body position.

To provide continuous action from exit to reserve drill, i.e. (develop an awareness of time)

To show the instructor that he is alert and in command of himself (high motivation here).

PERIOD 5

CANOPY CONTROL

OBJECTIVE

To familiarise the student with the phase of the jump from parachute opening to landing.

At the end of this period the student must understand what he must do to land safely on the DZ, and why.

EQUIPMENT (Optional)

- Photograph of DZ
- Training posters - of canopy
- Chalkboard
- Vertical suspended harness with toggles (recommended)

PRESENTATION

Briefly explain the main parachute and the control thereof.

Explain canopy control procedures

1. Check parachute OK (**Float, Shape, Spin**). Looks Good, Feels Good
2. Make a decision: continue or cutaway and open reserve.
3. Clear line twists if any.
4. Release brakes and cycle for 5 seconds.
5. Check end cells open and slider down.
6. Control test - Left and Right turn (minimum 180 degree) and full flare.
7. Make a final decision to land this parachute or to cutaway and open reserve parachute.

Orientation to drop zone or alternative landing area.

Now fully explain control of parachute.

Explain the standard landing pattern and why it is used.

The potential hazards in low (hook) turns or any other radical manoeuvres when using ram air canopies.

RULES:

- NO more than one 360 degree turn in any direction.
- NO more than a 180 degree turn below 1000ft.
- NO more than a 90 degree turn on final approach.

Priority of landing:

- Flat wing and a clear area
- Flare for landing
- Preferably into wind

Introduce any canopy control aids e.g. radios, arrow, batons.

Cover reserve canopy control procedure.

REVISION

Revise the complete control procedure.

TEST AND CONSOLIDATION

Evaluation by means of questioning is most appropriate for this lecture.

PERIOD 6A**MALFUNCTION THEORY****OBJECTIVE**

To teach the student to recognise a malfunction at the CHECK or CONTROL test stage.

EQUIPMENT

Diagrams or photographs of the different types of malfunction.

PRESENTATION

Types of malfunctions: Note all of these can be recognised in the two checks as discussed above.

- (High speed or fast malfunctions:)
 - Total (after hook-up or a pack lock)
 - Bag lock
 - Streamer or sniveller (slider stuck up)
 - Horse-shoe
- (Low speed or slow malfunctions:)
 - Tears or blown cells
 - Broken lines (steering or suspension)
 - Slider stuck - refuses to come down
 - Rotating malfunction
 - Bird's nest
 - Line-over
 - Steering-line hang up
- Hook-ups
 - Static line hook-up
 - Canopy hook-up

Brief the student on correct procedures for handling abnormalities:

- Line twists - situation must be improving
- Premature brake release on opening
- Two canopies out - don't cut away, steer the main parachute conservatively for a safe landing. If downplane starts developing, steer main towards reserve.

IF THE SITUATION IS NOT IMPROVING WITHIN 5 SECONDS OF "CHECK" PERFORM FULL RESERVE DRILL**REVISION**

Summarise lecture content.

TEST AND CONSOLIDATION

Evaluation by means of questioning is most appropriate for this lecture.

PERIOD 6B

RESERVE DRILLS

OBJECTIVE

To teach the student an instinctive reserve drill procedure which will automatically be carried out as a reflex action after “5000 check” and once a malfunction has been identified.

EQUIPMENT

Cutaway harness.

PRESENTATION

Explain the cutaway and reserve deployment to include the following:

- Action of the cutaway handle. Action of the RSL Deployment assisted by a spring loaded pilot chute
- Reserve Procedure

Explain the cutaway and reserve drill as follows: **ARCH, LOOK, HANDLES, RIGHT, LEFT, ARCH!**

- ARCH (let go of toggles/rip cord).
- LOOK and recognise the cutaway puff and reserve ripcord handle.
- HANDLES (firmly grasp both handles simultaneously).
- RIGHT, with the RIGHT HAND peel away the cutaway puff and punch it towards the crotch.
- LEFT, with the LEFT HAND punch the reserve ripcord handle towards the crotch.
- ARCH, return to ARCH.

Practice

All students should be taken through the drill slowly at first until everyone has mastered the drill. The class should then be speeded up until normal speed is reached. The following points should be emphasised and checked.

- The LOOK and HANDLES phases should not be rushed.
- The student must SEE and FIRMLY GRASP the cutaway puff and reserve ripcord with his thumb inside the ripcord handle.
- The commands should be loud.
- All actions should be aggressive.

Once all the students have achieved an acceptable reserve procedure the exit and reserve procedures should be combined. It is good practice every once in a while to stop the class after the CHECK and go through the drills for checking and clearing their canopies.

All students **must** be trained in a cutaway harness.

Impress on the students the importance of cutting away before deploying their reserve and the fact that the RSL is an extra safety device and should not be depended upon.

REVISION

This is one of the most critical periods. At the end you must have a student with a reflexive, instinctive reserve drill firmly embedded in his subconscious mind, which will surface even if the conscious mind is disorientated. Whether a student survives a malfunction depends entirely on how you conduct this lesson. **DO NOT OVERDO** it to the point of making the student “reserve happy”. Finish by revising the different types of malfunctions.

TEST AND CONSOLIDATION

Practically evaluate each student on the reserve drills and question them with regard to the purpose of each of the six distinctive movements.

PERIOD 7A**LANDINGS****OBJECTIVE**

To teach students to instinctively adopt a correct position for landing and to land softly.

EQUIPMENT

- Overalls
- Platform
- Landing mats

PRESENTATION

Explain and demonstrate the parachute landing position emphasising the following points:

- Feet and legs together - toes, ankles and knees pressed together.
- Feet flat.
- Feet underneath the body. Emphasise this point as the harness will tend to push the feet in front of the body.
- Knees slightly bent and legs firm.
- Hips pushed forward (helps get feet beneath body)
- Shoulders rounded.
- Chin on chest.
- Hands in crotch as low down as possible to flare the parachute.
- Student should be looking out as far as possible.

Get the students to get into the parachute landing position and critique them in it.

Teach the students the five points of contact

- Feet
- Calf
- Thigh
- Back
- Opposite shoulder

Practice the students in PLFs starting first with them on their knees (so they do not start by hurting themselves) and then on their feet giving assistance where necessary. Ensure the students are rolling properly.

- The shock must be taken with both feet flat on the ground.
- The side of the leg is forced to the ground.
- Feet and knees kept together.
- Roll along the thigh.
- Continue across the buttocks and over the shoulder.
- Turn the upper body while rolling i.e. shoulder away from ground.
- Keep elbows in and chin on chest.
- Follow up the roll to end with feet pointing in direction of travel.

After landing get up immediately to indicate that they are not hurt.

Stand-up Landings

- One foot directly underneath the body.
- The other foot extended in front of the body - this foot is what takes most of the landing force.
- Be prepared to run off the forward foot.

- Students, especially on their first jump, should prepare for a landing roll and only attempt a stand-up if they think that they are descending slowly enough.
- Face into wind
- Once committed to flare - do not let up toggles!

Post-landing Procedures

- After touch down, collapse the canopy – pull on one toggle, let the other go.
- Run around the canopy (downwind of the canopy) if the wind keeps re-inflating your canopy.
- Gather/loop the lines hosepipe fashion while walking towards the canopy. Watch for dragging of the canopy or the pilot chute. Place the lines on top of the canopy and fold the fabric inwards to make a small parcel.
- Walk back to the packing area - be aware of other canopies coming in to land.
- Exercise caution when crossing the runway - walk around or follow the procedure specific to your drop zone.
- Lay your canopy out and call a packer/instructor to help you pack.
- Learn to pack for yourself as soon as possible.
- Get debriefed and have your logbook completed before your next jump or before you leave the drop zone.

REVISION

Summarise the lecture content

TEST AND CONSOLIDATION

Every student must be practically evaluated on all types of parachute landing rolls. Do not accept anything less than perfection.

PERIOD 7B**HAZARDOUS LANDINGS****OBJECTIVE**

To teach the student to land as safely as possible on obstacles when they cannot be avoided.

EQUIPMENT

Aerial photograph of the Drop Zone showing surrounding obstacles. Or discuss this at landing area with students identifying hazards.

PRESENTATION

Obstacles can easily be avoided but there will be situations when hazardous landings can occur. If a hazardous landing is unavoidable the student should prepare early for it and remain calm. Most injuries in hazardous landings occur when a student forgets his drills and panics. Teach students about "hazard fixation" i.e. look away from an approaching obstacle to find the safest landing area and turn just enough to avoid it.

Trees

Should it seem inevitable that you are going to land in a tree the following should be done:

- With toggles in hands and elbows in, cover face.
- Keep your legs very firmly together
- Remain in this position until stationary (most people go through the tree and land on the ground).
- If suspended above the ground, await assistance.

Buildings

Buildings should be approached on half to full brakes and a PLF executed (if you hit the side of the building you will have to roll on the ground anyway). Immediately AFTER landing hold one toggle down and drop the other so as to collapse the parachute or cut away main.

Water

Water should be treated with respect. Safe water landings can be done by following this procedure:

- Try to land as close to the shore as possible
- Undo the chest strap
- Remain in a good parachute landing position (water may be shallow with a rough bottom).
- Land into wind flaring normally.
- Once WET, and not before, loosen leg straps and free yourself from your harness.
- Remove excess clothing and swim to shore

Power lines

Power and telephone lines can easily be avoided but should it become plain that you are going to land on one, go onto half brakes and try to avoid touching more than one line. If suspended allow NO ONE to touch you until your instructor arrives.

Roads and Runways

If you cannot avoid these, get off the surface as soon as possible after landing.

REVISION

Summarise the lecture content. Stress avoidance! Straight line features are usually hazardous.

TEST AND CONSOLIDATION

Evaluation should take the form of questioning but stress that obstacles should be avoided at all times.

PERIOD 8**REVISION, TEST AND CONSOLIDATION****OBJECTIVE**

To evaluate the student on his performance of all the drills covered during the course and to question him on the more important aspects of the course.

EQUIPMENT

Written test papers (optional, but strongly recommended).

PRESENTATION

This session can take the form of a sit-down test or of an oral evaluation session.

If it is only an oral evaluation then you must ensure that no students are left out of the questioning - each student must demonstrate a working knowledge of all the work covered in the First Jump Course.

REVISION

Use this period to summarise the whole course content, linking the lectures chronologically according to the phases of the jump.

TEST AND CONSOLIDATION

If the student has not done cutaway training in a suspended harness this must be done now along with any additional exit training in a harness if possible.

4 STUDENT PROGRESSION

4.1 GENERAL PROCEDURES

- A major cause of student problems is too rapid a progression rate combined with an inadequate training programme.
- In progression, a small point overlooked in early stages can create serious, if not dangerous, problems in later jumps.
- **NB:** Dropping back one level of progression (i.e. 10 second to 5 second) to correct a fault is often the fastest method of advancement.
- Students must always strive for perfection in their performance. A conscientious instructor will demand perfection from his students prior to allowing advancement.
- Prior to advancement, a student must perform all phases of a level to a minimum standard of 80% or higher.
- Emphasis must never be placed on quantity, "QUALITY" is essential.
- The maximum number of jumps which the average student can perform in one day and still advance at 100% of his ability is approximately three.
- Students must be trained on an individual basis according to ability and must never be allowed to progress beyond their capabilities. To do so is definitely hazardous.
- The progression rate outlined in this manual is the maximum rate recommended by the National Safety and Training Officer (NSTO). It is rewarding to the natural, an accomplishment for the average and demanding of the slow learner.
- Individual training records should be kept on each student and used in conjunction with the individual's log book.
- An accurate and detailed briefing, observation and de-briefing must be made on every student if they are expected to learn at their maximum rate.
- Any student whose performance creates a hazard to his safety on a continued basis, without any sign of improvement, **MUST** be told to quit sport parachuting. This is a difficult decision to make, especially with an enthusiastic student, but necessary to maintain the safety standards of the sport. Such decisions should be left to the Chief Instructor of the DZ.

4.2 LEVELS OF PROGRESSION

The numbers do not necessarily coincide with the student jump number (except maximum progression) but represents levels of skill or achievement in the sport. The points listed with each level are the minimum acceptable performance requirements, which must be achieved by the student prior to progression being allowed.

Levels of Progression Rating of Student Performance:

Excellent	(90-100%)	Maximum progression allowed.
Good	(80-89%)	Acceptable for progression.
Poor	(60-79%)	No progression allowed. Repeat required.
Weak	(Up to 59%)	Additional ground training mandatory prior to jumping again, possible regression and/or possible washout.

Except when on a PANAM-approved AFF, or Tandem Instruction programme, a Student Parachutist shall meet the following requirements before carrying out a freefall parachute descent:

- Complete a minimum of eight static line (SL) jumps of which three are no task jumps.
- Successfully complete a minimum of five consecutive stable dummy ripcord pulls of which the last three are consecutively good or excellent.
- Be approved for freefall by his Chief Instructor.

First Jump static line Spread Eagle position

- Good exit, arch and count with head back and toes pointed.
- Locked in spread eagle minimum of 5 seconds.
- Good canopy check (aware of colour) etc.
- Good performance on ground control.
- Good landing

Static line Spread Eagle, same count

- Good exit, arch and count with head back.
- Correction of all faults of previous jump.
- Locked in position for full 5 seconds.
- Good canopy check. Control and landing.

NOTE: Three consecutive no-task jumps rated at 80% or higher are required prior to progression into DRCPs. A student rushed into DRCPs will have numerous problems with them, and will have trouble progressing onto freefall. Aircraft awareness is a good indicator.

DRCP

OBJECTIVE

To teach the student how to pull his own ripcord, starting by performing a **dummy ripcord pull** – while adopting the correct student arch position with the correct time delay.

Spread eagle (Arch 000, Two 000, Reach 000, Pull 000, 5000, Check)

- Good exit and spread arch prior to starting the DRCP.
- Cleanly pulling the dummy without loss of arch or inducing body bank.
- Maintaining arch throughout the DRCP with synchronised movement of the arms.
- Forcing arch on pull, and holding arch through Check.

Subsequent DRCP jumps

- Same position and count.
- Same as previous jump with correction of faults from the previous jump (marked improvement).

Last three DRCP jumps

- Same as previous jump, performance must be in the 85-100% range by now.
- Student should be seeing the aircraft for the initial two seconds for orientation purposes.
- Satisfactory progression in canopy control and landings.
- Student must have self-confidence.
- Instructor must be 100% positive that the student is ready for freefall, mentally and physically.

First Free Fall

- Same count as DRCP (3500 feet AGL)
- Locked into arch prior to pull and not rushing.
- Proper time sequence on count.
- Maintain arch throughout 6 seconds (or to inflation).
- Satisfactory in canopy control and landing.

The student is now on the freefall progression programme.

After completion of freefall progression programme, the student is a graduate skydiver and must complete the Intermediate Skills Programme before progressing via a recognised discipline's Category programme in order to obtain further licences.

NB: A jumper is considered a student until he graduates from the freefall progression programme.

Levels of Knowledge

- | | | |
|---|-----------------------|--|
| • | Student/ intermediate | Eager to learn and improve skills. |
| • | "B" Licence Holder | Often over-confident. |
| • | "C" Licence Holder | Thinks he knows everything in the world about parachuting. |
| • | "D" Licence Holder | Begins to realise how much more there is to learn about the sport, usually self confident and competent. |

If there is a considerable length of time between jumps, a student should either repeat the performance of his jump, or drop back one level. Never attempt something entirely new and different or use strange equipment after a lay-off from active jumping. See currency requirements.

5 FREEFALL PROGRESSION

TEST 1

FIRST FREEFALL (3 SECOND DELAY)

OBJECTIVE

To teach the student how to safely perform his **first short delay** freefall - by adopting the correct student arch position with the correct time delay.

EQUIPMENT

- Freefall rig of the type being used
- Mannequin - to illustrate body positions in freefall
- Suspended harness, training trolleys
- Video (recommended) preferably to go with manual.

PRESENTATION

- Student must be cleared for freefall by the CI. Instructor to do this briefing.
- Explain the freefall programme, how it works, who can sign it etc.
- Explain freefall equipment fully including deployment system and AAD.
- Student must do exactly the same count and action as his last DRCP and his first freefall must be done within a day of each other.
- Explain floating ripcords and stoppages - try once to remedy the situation and then use your reserve.
- Review freefall malfunctions - total, horseshoe etc.
- Review emergency exit procedures - use reserve below 3000 ft.
- Explain different sensations that are encountered i.e. slower opening, added nervousness etc.
- Maintain arch through to check and then do a proper check.
- Any time the student goes unstable, loses count or gets disoriented he must arch hard and deploy main immediately.
- Recommend that the student uses goggles from now on.
- Discuss gloves.

NB: Test reserve drills again.

NB: Three priorities of freefall to be introduced. Student to write into own logbook.

1. PULL A RIP CORD
2. PULL AT THE RIGHT ALTITUDE
3. PREFERABLY PULL STABLE

NB: Stress the overriding importance of 1 and 2.

REVISION

Summarise the lecture content.

TEST AND CONSOLIDATION

- Student should do a 3 second delay.
- A positive arch should be maintained from exit to check with no kicking and fighting.
- A clean pull.
- A good recovery back into the arch.

NOTES

Unless the student's performance is very bad the student should be passed on to a 5 second delay as faults may be easier to correct with a slightly longer delay. If the jump is really terrible the student should be returned to the dummy ripcord phase.

**PULL A RIP CORD
PULL AT THE RIGHT ALTITUDE
PREFERABLY PULL STABLE**

TEST 2**FIVE SECOND DELAY****OBJECTIVE**

For the student to do a slightly longer delay while keeping his arch.

EQUIPMENT

- Freefall rig of the type being used
- Mannequin - to illustrate body positions in freefall
- Suspended harness, training trolleys
- Video (recommended)

PRESENTATION

- Explain the different count sequence (Arch 1000, 2000, 3000, 4000, Reach thousand, Pull thousand, 5000, check).
- Explain the necessity for keeping a hard arch all the way through the pull and then to check properly.
- Stress that all instability can be overcome by a hard arch.
- The student should be able to see the aircraft throughout the count.

REVISION

Summarise the lecture content.

TEST AND CONSOLIDATION

- Student should pull within a second of five seconds.
- The student must maintain a hard arch throughout the jump.
- The student must maintain his stability while deploying i.e. correct symmetry of arms (left hand in front of eyes) while pulling.

PULL A RIP CORD
PULL AT THE RIGHT ALTITUDE
PREFERABLY PULL STABLE

TEST 3**TEN SECOND DELAY WITH BOX/NEUTRAL POSITION - 2 Jumps****OBJECTIVE**

For the student to experience a delay allowing him to almost reach terminal velocity and to reach a proper face to earth position while maintaining stability.

EQUIPMENT

- Freefall rig of the type being used
- Mannequin - to illustrate body positions in freefall.
- Suspended harness, training trolleys.
- Video (recommended)

PRESENTATION

- Explain the box/neutral position fully.
- Explain the different count sequence (1000 - 9000 , reach thousand, pull thousand, 5000, check).
- Brief the student on falling faster and flatter. Refresh attitude to relative wind.
- The student should watch the plane for the first few seconds and then alternately watch the ground and the horizon.
- The student should be told about buffeting and rocking, not to worry, just to relax into the box/neutral position after 4 seconds.
- The student must deploy at the correct time regardless of what is happening.
- If instability is encountered the student should push hips forward and if that does not correct the situation, he should deploy immediately.

REVISION

Summarise the lecture content.

TEST AND CONSOLIDATION

- The student must be completely stable throughout the whole jump including while he is deploying.
- The student should not turn off more than 90 degrees.
- The student should deploy main within a second of ten seconds.
- The student's awareness should be increasing through all stages of the skydive.

NOTES

Two good jumps are required on this test as the student is doing longer freefalls. Many freefall problems can be corrected at this stage giving the student a chance to progress smoothly through the rest of his freefall progression programme.

**PULL A RIP CORD
PULL AT THE RIGHT ALTITUDE
PREFERABLY PULL STABLE**

TEST 4**FIFTEEN SECONDS BOX/NEUTRAL POSITION ON HEADING****OBJECTIVE**

For the student to develop a feel of balance and to use the wind to achieve stability rather than rely on a forced arch. The student will be starting to control his heading from now on.

EQUIPMENT

- Freefall rig of the type being used
- Mannequin - to illustrate body positions in freefall
- Suspended harness, training trolleys
- Video (recommended)

PRESENTATION

- Explain the different sequence (1000 - 14000, reach thousand, pull thousand, 5000 check).
- Tell the student he will now be falling at terminal velocity (approx. 200 km/h) and should be falling flat by 10 seconds.
- After four seconds the student should relax into the box/neutral position.
- The student should keep his eyes on the horizon while he is in the relaxed position with occasional glances at the ground.
- If instability is encountered the student should push hips forward and if that does not correct the situation, he should deploy immediately.
- Explain the theory of turns. Asymmetric body position is what causes a turn and that this asymmetric position may be caused by an unevenness of the arms or legs.
- To stop a turn you should look over the opposite shoulder. To stop a turn it is usually enough to watch a selected point on the horizon.
- Reiterate that the student must deploy on time.
- The student may do his own spot from now on (depending on the type of aircraft being used).

REVISION

Summarise the lecture content.

TEST AND CONSOLIDATION

- The student should be able to fall in a box/neutral position without any signs of buffeting or rocking.
- The student should stay within 30 degrees of his heading.
- The student should deploy within two seconds of fifteen seconds.

PULL A RIP CORD**PULL AT THE RIGHT ALTITUDE****PREFERABLY PULL STABLE**

TEST 5**FIFTEEN SECOND COUNT WITH ALTIMETER/ALTITUDE AWARENESS****OBJECTIVE**

To teach the student the care and use of an altimeter and its limitations. To make the student more altitude aware while he is still counting the freefall delay.

EQUIPMENT

- Freefall rig of the type being used
- Mannequin - to illustrate body positions in freefall
- Suspended harness - training trolleys
- Video (recommended)
- Altimeter

PRESENTATION

- The same count sequence as for the fifteen second delay is to be used.
- The altimeter must be in an easily visible place.
- It is recommended that the altimeter be worn on the wrist.
- If possible the needle of the altimeter should be at its most visible at opening altitude i.e. the 3000 on the altimeter away from the body so the needle is pointing out.
- A student with a newly acquired altimeter should have it checked by a senior jumper prior to using it.
- Students should be warned that altimeters are mechanical devices and are not foolproof. A sense of altitude awareness must be developed using both a sense of time and visual checks of the ground. If a student's altitude awareness says he is lower than his altimeter says, the student should rely on his altitude awareness.
- If the student cannot see his altimeter or is unsure of his altitude he should deploy the main immediately.
- The student must not stare at his altimeter. When checking his altimeter he should glance at the altimeter, glance at the ground and then back at the horizon.
- The altimeter should be set on the ground and then checked at 1000 ft and just before exit. Under no circumstances must the altimeter be adjusted in the aircraft even while the aircraft is on the ground as the prop blast can lower the air pressure inside. Care must be taken of an altimeter at all times especially in the aircraft as it is a delicate piece of equipment.
- The altimeter should be checked just before exit, at 5 sec. at 10 seconds and while deploying. The student must be able to tell his instructor what heights these were.

NB: Review and test reserve drills.

REVISION

Summarise the lecture content.

TEST AND CONSOLIDATION

- Understand the use and limitations of an altimeter.
- Be able to remember the heights he was at during the various checks.
- Show no signs of instability while checking his altimeter.
- Be able to maintain a box/neutral position during the whole dive.

PULL A RIP CORD**PULL AT THE RIGHT ALTITUDE****PREFERABLY PULL STABLE**

TEST 6**TWENTY SECONDS POISED EXIT WITH ALTIMETER AND INTRODUCTION OF WAVE-OFF****OBJECTIVE**

To get the student used to using an altimeter for longer delays and to develop ground awareness.

EQUIPMENT

- Freefall rig of the type being used
- Mannequin - to illustrate body positions in freefall
- Suspended harness, training trolleys
- Video (recommended)
- Altimeter

PRESENTATION

- The altimeter is to be used from now on but a sense of time awareness should be cultivated - possibly mental counting. Visual checks must also be used - check the altimeter and then check the ground.
- Introduce the wave-off and safety application thereof. i.e. opening signal.
- The student must remain on heading, his heading picked on the horizon and not directly below him.
- Before deploying the student must wave off.
- The wave off should be a crossing of the wrists in front of the head while in the box/neutral position.

REVISION

Summarise the lecture content.

TEST AND CONSOLIDATION

- The student should remain on heading for the whole jump.
- The student should be seen to wave off clearly before opening.
- The student should be opening between 3500 ft and 3000 ft.

PULL A RIP CORD**PULL AT THE RIGHT ALTITUDE****PREFERABLY PULL STABLE**

TEST 7**TWENTY SECOND DIVE EXIT****OBJECTIVE**

To teach the student to do a dive exit maintaining control and remaining stable throughout the dive.

EQUIPMENT

- Freefall rig of the type being used
- Mannequin - to illustrate body positions in freefall
- Suspended harness, training trolleys
- Video (recommended)
- Mock-up/aircraft
- Altimeter

PRESENTATION

- Revise relative wind and box/neutral position.
- The student should dive down, if he dives out too flat the prop-blast will catch him on the side and he will probably go unstable.
- The student should stretch his arms forward and relax, tuck back his legs so that the prop-blast does not flip him over. The student will feel as if he is going over but must remain in this position until he can see the horizon, at which time he must relax into a normal freefall position.
- If the student goes unstable he should arch.

REVISION

Summarise the lecture content.

TEST AND CONSOLIDATION

- The student should be stable by 5 seconds after exit and should maintain his heading for the duration of the dive.
- The student should be seen to wave off clearly before opening.
- The student should be opening between 3500 ft and 3000 ft.

NOTES

Don't worry if the student does not handle the exit too well as he will have plenty of other opportunities to get it right.

**PULL A RIP CORD
PULL AT THE RIGHT ALTITUDE
PREFERABLY PULL STABLE**

TEST 8**180 DEGREE TURNS IN BOTH DIRECTIONS****OBJECTIVE**

To teach the student how to execute and control 180 degree turns in both directions and be able to stop the turn.

EQUIPMENT

- Freefall rig of the type being used
- Mannequin - to illustrate body positions in freefall
- Suspended harness - training trolleys
- Video (recommended)

PRESENTATION

- Explain again the theory of turns - asymmetric body position will create a turn. Mention inertia.
- Explain how to control turns. Turn your head in the direction of the turn (look where you're going) and look over your shoulder. Bank the upper body while keeping the lower body neutral.
- The turn should be stopped just before the heading is reached so that the student does not over-shoot. The turn is stopped by returning to the neutral position and countering in the opposite direction if required.
- The student should only start working after 5 seconds or more so that he has completely recovered from his dive exit and has built up some speed.
- There is no need to rush. Slow, good turns are better than fast turns that go past their headings.
- If a spin is encountered, push hips forward and counter in the opposite direction. If that doesn't stop it, deploy main.
- The altimeter should be checked after each turn.
- Briefing should be done with the aid of a harness, training trolley or other training aid.

NB: Review and test reserve drills.

REVISION

Summarise the lecture content.

TEST AND CONSOLIDATION

- The student should do at least one turn in each direction.
- Each turn should be within 20 degrees of 180 degrees.
- The student should be seen to wave off clearly before opening.
- The student should be opening between 3500 ft and 3000 ft.

PULL A RIP CORD**PULL AT THE RIGHT ALTITUDE****PREFERABLY PULL STABLE**

TEST 9**360 DEGREE TURNS IN BOTH DIRECTIONS (TEST)****OBJECTIVE**

To teach the student how to execute and control full turns in both directions and be able to stop the turn.

EQUIPMENT

- Freefall rig of the type being used
- Mannequin - to illustrate body positions in freefall
- Suspended harness, training trolleys
- Video (recommended)
- Altimeter

PRESENTATION

- Brief as per test 8.
- The student should know that the turns are executed exactly the same way as 180 degree turns but that more speed (momentum) can build up.
- For this reason the student should start stopping the turn about 90 degrees before the heading is reached.
- Again slower, controlled turns are better than fast, sloppy turns.

REVISION

Summarise the lecture content.

TEST AND CONSOLIDATION

- At least one turn in each direction must be performed.
- Each turn must be within 20 degrees of the chosen heading.
- The student should be seen to wave off clearly before opening.
- The student should be opening between 3500 ft and 3000 ft.

NOTES

Students should be completely proficient in turns before passing this test.

PULL A RIP CORD
PULL AT THE RIGHT ALTITUDE
PREFERABLY PULL STABLE

TEST 10**BACKLOOPS****OBJECTIVE**

To teach the student how to recover stability if he is knocked unstable on break-off or some other out of the ordinary circumstances.

EQUIPMENT

- Freefall rig of the type being used
- Mannequin - to illustrate body positions in freefall
- Suspended harness, training trolleys
- Video (recommended)
- Altimeter

PRESENTATION

- The student should delay for about 5 seconds before attempting backloops to ensure that he is properly stable and has built up enough speed.
- Show the students how to do backloops:
 - Head up and knees up.
 - As the knees come up push down with the arms keeping the arms 45 degrees away from the body.
 - As the legs come under the body the student should kick his legs out.
 - Keep the head back and as soon as he sees the ground arch to get back to the stable position.
- The arms are the pivotal point of the backloop and should be kept out from the body and never brought in to the sides.
- The backloop must be done fairly quickly, it is almost impossible to do a backloop slowly.
- If a student finds himself on his back in an arch, he should pull in one arm and then re-arch.
- The altimeter must be checked after each backloop and the student should be aware of the excessive altitude loss during backloops.

NB: No backloop may be performed below 4500ft

REVISION

Summarise the lecture content.

TEST AND CONSOLIDATION

- The student should be able to recover stability at least twice.
- An option is to brief the student for an intentional front loop on exit.
- Once recovered he checks his alti and then performs a back loop, thus demonstrating recovery twice.
- The student should be seen to wave off clearly before opening.
- The student should be opening between 3500 ft and 3000 ft.

PULL A RIP CORD

**PULL AT THE RIGHT ALTITUDE
PREFERABLY PULL STABLE**

TEST 11**FULL (INTERNATIONAL) SERIES (TEST)****OBJECTIVE**

To give the student more work in the air and to test his ability to think in the air as a sequence of manoeuvres have to be put together.

EQUIPMENT

- Freefall rig of the type being used
- Mannequin - to illustrate body positions in freefall
- Suspended harness, training trolleys
- Video (recommended)
- Altimeter

PRESENTATION

Brief the student on a full series:

- Backloop / alti
- Right turn / alti
- Left turn / alti
- Backloop / alti
- Left turn / alti
- Right turn / alti

There is not an excessive amount of time to do this test and so the student should not waste time before starting and should do each manoeuvre as quickly as he feels he can manage it.

Student should be practised within the allowed time. i.e. 25 seconds.

NB: No backloop below 4500ft.

REVISION

Summarise the lecture content.

TEST AND CONSOLIDATION

- All turns and backloops should be within 20 degrees of heading.
- The student should be able to complete the whole full series.
- The student should be seen to wave off clearly before opening.
- The student should be opening between 3500 ft and 3000 ft.

PULL A RIP CORD**PULL AT THE RIGHT ALTITUDE****PREFERABLY PULL STABLE**

TEST 12**DELTA IN TWO DIRECTIONS****OBJECTIVE**

To teach the student a method of getting down to other skydivers while doing Formation Skydiving and is to be used as an introduction to tracking.

EQUIPMENT

- Freefall rig of the type being used
- Mannequin - to illustrate body positions in freefall
- Suspended harness, training trolleys
- Video (recommended)
- Altimeter

PRESENTATION

- Once stable and a heading 90 degrees to run-in has been obtained, the student should move slowly into the delta position. Rushing into the delta position could cause him to go unstable.
- Brief the student on the delta position as follows:
 - Straighten the legs.
 - Sweep the arms back from the body (approx. 45 degrees) and let the wind blow them back.
 - This should push the chest out.
 - Student should look where he is going.
- The delta should be held for about 5 sec. and then the student should arch out of the delta.
- Check alti.
- The student must turn 180 degrees and repeat the delta in the opposite direction.

NB: No delta below 4500ft.

REVISION

Summarise the lecture content.

TEST AND CONSOLIDATION

- The student should be able to delta twice without any signs of lateral instability.
- The student should be seen to wave off clearly before opening.
- The student should be opening between 3500 ft and 3000 ft.

**PULL A RIP CORD
PULL AT THE RIGHT ALTITUDE
PREFERABLY PULL STABLE**

TEST 13**DELTA & TURN****OBJECTIVE**

To teach the student how to control direction in a delta. This is a key safety manoeuvre and will be invaluable when skydiving with others.

EQUIPMENT

- Freefall rig of the type being used
- Mannequin - to illustrate body positions in freefall
- Suspended harness, training trolleys
- Video (recommended)
- Altimeter

PRESENTATION

- The student should delta for at least 5 seconds before attempting the turn.
- The student must be told how to turn in a delta:
 - Drop one shoulder slightly and look where he is going.
 - Push out the opposite arm slightly (right arm in a left hand turn).
- Tell the student if he turns too hard he will lose his lateral stability and "spiral". The turn should therefore be done slowly.
- The turn should be a 90 degree turn on preset headings. Tell the student which direction to start and what heading to turn onto.
- If the student goes unstable in the turn he should return to the box/neutral position. If time allows, try again.
- Flare, wave-off and deploy by 3000 ft.

REVISION

Summarise the lecture content.

TEST AND CONSOLIDATION

- The student must be able to delta without any signs of lateral instability.
- The student should be seen to wave off clearly before opening.
- The student should be opening between 3500 ft and 3000 ft.

NOTES

It is imperative that the student be able to delta properly before he can safely progress.

PULL A RIP CORD**PULL AT THE RIGHT ALTITUDE****PREFERABLY PULL STABLE**

TEST 14**DELTA & TRACK****OBJECTIVE**

To teach the student how to transition a delta into a flat track.

EQUIPMENT

- Freefall rig of the type being used
- Mannequin - to illustrate body positions in freefall
- Suspended harness, training trolleys
- Video (recommended)
- Altimeter

PRESENTATION

- Brief delta as per test 12.
- The student should delta for at least 5 seconds before attempting the track.
- Brief the track as follows:
 - From the delta, sweep the arms forwards to a straight line while rotating the palms through 180 degrees.
 - At the same time bring the legs together and point the toes.
- Maintain this position for at least 5 seconds. If time permits, do a 90 degree turn.
- Flare, wave-off and deploy by 3000 ft.

REVISION

Summarise the lecture content.

TEST AND CONSOLIDATION

- The student should be in complete control of his track at all times.
- The wave before deploying should be automatic by now.
- Priorities of freefall should be ingrained.
- The student should be opening between 3500 ft and 3000 ft.

PULL A RIP CORD**PULL AT THE RIGHT ALTITUDE****PREFERABLY PULL STABLE**

TEST 15**SPIN TEST****OBJECTIVE**

To teach the student to regain control at any time e.g. after being knocked unstable on break-off. This is the final test of the freefall progression programme.

EQUIPMENT

- Freefall rig of the type being used
- Mannequin - to illustrate body positions in freefall
- Suspended harness, training trolleys
- Video (recommended)
- Altimeter

PRESENTATION

- The student should delay for at least 10 seconds before attempting the spin test so that he can build up some speed.
- The spin is performed by starting with a 360 degree turn after which the student will grab an ankle and "salute" with the opposite hand.
- If the turn is to the right, the right ankle must be grabbed and the salute done with the left hand and vice versa for the left turn.
- To recover from the spin, return to an arch and force a turn in the opposite direction.
- If recovery is not achieved within 5 seconds, arch and pull.
- If recovery is achieved the student should wave-off and deploy by 3000 ft.

REVISION

Summarise the lecture content.

TEST AND CONSOLIDATION

- The student must go into a high speed spin and recover within 5 seconds.
- The student should be seen to wave off clearly before opening.
- The student should be opening between 3500 ft and 3000 ft.
- On successful completion, the student is a graduate skydiver and must complete the Intermediate Skills Programme before progressing via a recognised discipline's Category programme in order to obtain further licences. (See PANAM MOPs Section 2, 1.4)
- NB: This is to be logged. Chief Instructor to sign off the freefall progression sheet and the ISP to be explained to the student.

PULL A RIP CORD**PULL AT THE RIGHT ALTITUDE****PREFERABLY PULL STABLE**

6 HAND-DEPLOYED PILOT CHUTE CONVERSION

OBJECTIVE

For the student to learn a new deployment system.

EQUIPMENT

- Freefall rig of the type being used
- Mannequin - to illustrate body positions in freefall
- Suspended harness, training trolleys
- Video (recommended)

PRESENTATION

- The student shall be a graduate skydiver.
- The particular deployment system should be explained and demonstrated fully.
- Mention the alternative deployment systems i.e. BOC or pull out.
- Show the routing of the bridle cord and explain the importance of it.
- Show method of packing pilot chute and pin position.
- Show the pin and the piece of slack bridle created with Velcro to enable the pin to be easily extracted.
- Show the student how to deploy the pilot chute with his palm up to prevent the pilot chute or bridle tangling with his hand or arm.
- The pilot chute should be taken to arms length and released immediately. Normal check procedure.
- Malfunctions should again be reviewed and any new potential malfunctions introduced – pilot chute in tow, horseshoe, etc.
- Test reserve procedures. Mention need to ensure clear air below jumper before cutaway.
- Introduce collapsible pilot chutes.
- If a parachute of a different design and or smaller size is to be jumped, fully brief the student on this. Student to read “The Canopy Pilot’s Handbook” as contained at the end of this section. Student should be progressively stepped down from student canopy to the minimum size appropriate to his weight. See manufacturer’s recommendations.

Two separate jumps should be performed in order for the student to be fully familiar with the new deployment system.

• Jump 1

The student should exit at altitude and perform at least 3 dummy pulls where the student touches the handle but does not deploy it and then does a proper pull at 5000ft.

• Jump 2

A half series with dummy pulls between each manoeuvre. The student to deploy at 5000ft.

REVISION

Summarise the lecture content.

TEST AND CONSOLIDATION

- The student should have demonstrated his understanding of both the cut-away system and the deployment system:
 - Operation
 - Safety checks
 - Advantages and disadvantages over previously used equipment.
- The student must be able to deploy without going unstable.
- This conversion must be done before or after the ISP, not during.

7 TRANSITION TO HIGH PERFORMANCE PARACHUTES

INTRODUCTION

The high performance parachute presents substantial new challenges to the parachutist converting from the student square. This chapter is intended to guide the parachutist and instructor in the conversion. It is not intended to replace a thorough pre-jump briefing by a qualified individual.

The parachutist must:

- Have demonstrated consistent good canopy handling practices (i.e. no downwind landings, reasonable accuracy, etc.)
- Prior to making a first high performance parachute jump, the student should be thoroughly briefed by an instructor or Jumpmaster, and the parachutist should:
 - Become familiar with the varying relationships of forward speed and rate of descent.
 - Understand recommendations for flight in gusty and turbulent conditions.
 - Be familiar with procedures for recovery from stalls.
 - Understand the recommended methods for initiating and stopping turns.
 - Receive a thorough discussion of malfunctions and appropriate emergency procedures.
 - Participate in a thorough discussion of abnormal conditions which do not necessarily constitute malfunctions i.e. line twists, closed end cells, etc.
 - Clearly understand the potential hazards in low (hook) turns or any other radical manoeuvres when using higher performance canopies.
 - Be aware that the forward speed, vertical speed and handling characteristics differ greatly amongst High Performance parachutes.
 - Appreciate that several jumps need to be made on any parachute make or model (not type) before carrying out a demonstration jump with that parachute or, if at the CI's discretion, there is a risk that the parachutist may not be completely familiar with the parachute's flight characteristics or other potentially hazardous factors.
- The parachutist should demonstrate a basic understanding of the aerodynamic characteristics of high performance ram-air flight. It is not drag produced by the area of a square parachute that retards its descent; but the lift produced by its forward flight through the air. The forward speed of a ram-air canopy is not simply a desirable advantage, it is essential to its performance.
- Participate in packing the canopy to be jumped under supervision of a suitably qualified person. During packing, the parachutist should become familiar with:
 - The design and construction of the canopy including its cells, line structure and deployment system.
 - The method of stowing and releasing the brakes.
 - The general principles of packing the canopy according to the manufacturer's instruction.

SUGGESTED JUMP PLAN

Early jumps should be carefully planned to provide the parachutist with an opportunity for systematic exploration of the flight characteristics of the canopy.

First Jump

- Exit the aircraft solo at altitude sufficient to permit a terminal or near terminal opening at 4500 to 5000ft.
- After deployment and checking canopy, do not release brakes (unless necessary to clear end cells or bring down slider). Instead, make several rear-riser turns to left and right. Rear-riser turns without release of brakes may be needed to avoid other canopies.
- Release brakes and make 360 degree turns to right and left.

- Gently pull both toggles down towards waist, observing canopy stall point. Recover from stall by letting toggles up slightly.
- Set up for landing. If the drop zone permits, it is best to set up an aircraft-type approach, with downwind leg, crosswind leg, and 90 degree turn to final. Altitudes for these manoeuvres will depend on DZ layout, rate of descent, etc.; the instructor should be consulted for advice.
- Prepare to land.

IMPORTANT:

Be prepared to do a PLF if necessary. Flaring either too high or too low is a major cause of injuries among inexperienced ram-air jumpers. A flare is simply a controlled stalling manoeuvre. It is intended to convert the energy of the jumper's forward speed to lift, momentarily stopping or slowing the descent. Flaring too high means that at the moment the jumper hits the ground, his canopy has lost lift, and its rate of descent increases greatly. Flaring too late means the jumper is travelling at a higher-than-necessary rate of forward speed.

Flaring must be performed from full or near-full canopy speed, since it is that speed, transformed into lift, which momentarily slows the rate of descent. Many inexperienced ram-air jumpers, failing to understand this attempt to flare from a partial or near-full brake situation, resulting in a sudden stall and increase in rate of descent.

On the first few jumps, the parachutists should not attempt accuracy landings and not be concerned about landing some distance from the target. It is far better to make a safe landing off-target than a crash landing on target.

The novice high-performance ram-air jumper should consult with an instructor as to the appropriate altitude to set up landing approach for prevailing wind conditions.

SUBSEQUENT HIGH PERFORMANCE RAM-AIR JUMPS

After the first successful ram-air jump, the next several jumps should be carefully planned so that the parachutist will have an opportunity to explore the flight characteristics of the canopy.

The stall point should be checked on each jump, since it can be affected by atmospheric conditions.

Flight characteristics, which the jumper should study, include:

- The effect of holding the canopy in a steady-state stall (a stall entered from near full brake position for several seconds; recovery from this stall).
- A dynamic stall (a stall entered by rapid depression of toggles from near full flight to the stall position attempting a dynamic stall, and understand the recommended recovery procedure).
- Stall turns (turns entered by pulling down rear risers rather than toggles).
- Effect of pulling down front risers changing the angle of incidence and increasing forward speed but also rate of descent.
- Multi-revolution hard spiral turns (noting especially the rapid loss of altitude).

THE CANOPY PILOT'S HANDBOOK

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first edition, July 1997

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"The vast majority of parachuting injuries these days is related to canopy control (or lack thereof)."

INTRODUCTION

The following materials are presented to the skydiving public in the hopes of bringing up our level of performance and understanding. Anyone is free to copy this material. However, you are on your honor not to plagiarize or edit my work. If you choose to copy this material for instructional purposes, fine. All I ask is that I am credited as author and Skydive Arizona is also given credit, since these materials were developed partly on their time and with their instructional programs in mind. In addition, please do not change the text. If you feel the need to add to, subtract from, or contradict something, please do it in the form of foot notes. I look forward to hearing from anyone with comments, criticisms, or suggestions - but when it comes to adding or subtracting from the text, I reserve the right to do it myself.

At this time the Canopy Pilot's Handbook consists of five chapters. I plan to add a sixth chapter, on precision landings for modern parachutes, by the fall of 1997. There is an additional section at the end directed to people who may wish to teach canopy flying courses at their own drop zone. It offers a few suggestions. I would like to hear from people who host such courses; perhaps we can come up with some common denominators that will lead to better teaching.

Most of the material presented here came from long observation, experience, and thought. There aren't many sources of information out there, and some of those are incomplete or even inaccurate. But there are some good ones. Works that particularly influenced me are:

The Parachute Manual (v.II) by Dan Poynter. This fascinating volume (and v.I for the really hard-core enthusiast!) has a place in the library of any skydiving professional, especially riggers. For typical skydivers the \$49.95 price tag is a bit high, since two thirds of the book is devoted to specifics of rigging that aren't much use to the layman. The last third of the book, however, has interesting discussions on design, deployment, packing, malfunctions, etc. Some of the material is a bit obsolete since the latest revision that I know of was in 1991. Most research libraries have this book in their collection, so try the nearest university library or your local rigger if you want to look at the book before you lay out fifty bucks. It can be ordered through any of the big mail order parachute suppliers or direct from Para Publishing, PO Box 4232, Santa Barbara, CA 93140-4232, USA.

The Aerodynamics and Piloting of High Performance Ram-Air Parachutes by Jerry Sobieski. This is a very interesting treatise on how modern parachutes fly. Although it is written in the style of a college thesis even someone like me, who flunked calculus, can understand it. The first forty pages are a detailed technical analysis of how parachutes fly; the remaining thirty are about how to fly them. The author's e-mail address, last I knew, is jerrys@umiacs.umd.edu. The treatise can be found on the skydiving archive at <http://www.afn.org/skydive>. Quite a few other interesting things are there too; just browse through the safety and training section for information specific to canopy flying.

The owner's manuals that accompany new canopies usually have at least one or two useful nuggets of information. Performance Designs also has published two sets of lecture notes written by John LeBlanc. John is a very interesting man to talk to and gives seminars on canopy flying at many boogies and other skydiving events. You may want to contact PD and get these two notes. They are also available on the skydiving archive mentioned in the previous paragraph.

Talk to canopy manufacturers if you get the chance. Most of them have thought deeply about parachute performance. Unfortunately they tend to be a bit cagey when you get down to specifics of design, since they consider some of this information proprietary, and possibly potential liability. Still, most have some very interesting views on the subject. Most of them are also very busy people, so be sensitive to the possibility that they might not have a lot of time for idle chatter.

Most of all, keep your eyes open. In your skydiving career you will see far more landings than you will ever make. All of them are learning opportunities.

Blue skies, soft landings

Bryan Burke

*Safety and Training Advisor at Skydive Arizona
USPA National Director, 1997-98*

Chapter One: BASIC AERODYNAMICS

The forces that affect a parachute are invisible, but not incomprehensible. Learn what makes a parachute fly well and you will know what makes it fly badly.

There are two basic ways for parachutes to slow our descent - lift and drag. A round parachute creates drag by simply grabbing as much air as it can, putting on the brakes for us. But a square parachute creates lift, which forces an air foil in a particular direction determined by the design of the foil and its presentation to the fluid it moves in. Controlling the flow of air over the foil is the art of the canopy pilot.

Lift

A canopy produces lift in two ways. The form of the wing itself produces some lift. Wings are shaped so that air must flow faster over the top of the wing than the bottom. When the velocity of air increases, its pressure decreases. This creates a low pressure area on the top of the wing, and a corresponding higher pressure below. Thus the wing is "lifted" towards the low pressure area.

Deflection of air is the second type of lift. If air is deflected one way, there must be an equal reaction in the opposite direction - the same principle that lets us turn, track, and perform other freefall maneuvers.

The balance of deflection and form lift is a complex one. If deflection were the principle source of lift, in a right toggle turn (the right trailing edge pulled down) air deflected downward would push the right side of the canopy up, putting the canopy in a bank to the left and creating a left turn. But in fact, pulling the right toggle down reduces lift, because it increases drag on that side. With the right side moving slower, it creates less lift. The canopy banks to the right.

The main skydiving use of deflection is at flare time. When a canopy is flared, some air is deflected downward with a resultant upward motion of the canopy. But this also increases drag, slowing the canopy's forward speed. The pilot beneath, having more mass and less drag, does not slow down as fast and swings forward. This changes the entire angle of attack of the canopy, greatly increasing deflection of air as long as any airspeed remains. We'll look more closely at this use of deflection when we discuss angle of attack, and in the chapters on practical flying techniques.

Drag

The other main force acting on a canopy is drag. Drag also has two manifestations, which I will call form drag and parasite drag. Put simply, form drag is the result of friction between the air flow and the wing. It is a penalty all wings incur to some extent and you can even think of it as lift - towards the back! Parasite drag is the result of disruptions of the air flow from irregularities in the wing. The cell openings create turbulence. Seams, packing tabs, lines and line attachment points, the pilot chute, the slider, and even you, the pilot, contribute drag but no lift. Parachutes have never been very effective wings in comparison with airplanes because their very structure creates a great amount of parasite drag.

Lift and drag, then, are both results of airflow over a wing. Because it is the flow of air over the wing that creates these flight forces, more flow means more force. Lift and drag increase in geometric proportion to speed: twice the speed, four times the lift - and the same for drag. This means that airspeed is crucial to performance. Going faster means - to a point - more lift and crisper control response. It also means drag goes up, which is why fast canopies have several design features to reduce drag such as removable pilot chutes, collapsible sliders, and small diameter lines.

Flow Separation

Fluids flowing over a foil have another interesting characteristic - one you can easily see by watching water pass over a rock in a stream. The fluid will try to follow the curves of an object in the smoothest possible path. A foil can have its shape changed to some extent without disrupting the flow. The direction of flow can also change slightly without disruption, but if either the direction of flow or the shape of the foil changes too rapidly, "flow separation" occurs. Instead of cleanly following the shape of the foil, the fluid breaks loose in eddies and ripples. This is very important to canopy pilots because in essence it means that any sudden, radical maneuver greatly reduces the lifting efficiency of the foil by reducing form lift. The most common and dramatic example of flow separation for parachutes is a slow speed stall, but as we will see in later chapters, there are many more subtle variations: excessive front riser input, "pumping" the toggles, and extreme toggle input.

Thrust and Weight

For a wing to move through the air and produce lift, there must be some force propelling it. Normally this is called thrust. In an airplane it is easy to understand - the engine does the work. With a sport parachute gravity is the engine. On a ram air parachute, the A (leading edge) lines are shorter than the D (trailing edge) lines, causing the canopy to have a downward tilt. Air is deflected towards the back of the wing, causing forward speed. The weight of the system (you, plus the gear) pulls down on the wing. The wing is sliding, like a sled on a hill, down a slope determined by the trim of the suspension lines.

The more the weight pulls down, the more thrust you get. We commonly refer to the relative amount of weight under a wing as "wing loading," an important term to canopy pilots. In America parachute loadings are based on exit weight - the combined weight of the jumper and all equipment - and expressed as a ratio of pounds per square foot of canopy. This can lead a pilot into the assumption that wing loading remains constant, and in straight and level flight this is true.

However, wing loading can change dramatically during a turn. To illustrate the concept simply think of a weight swung on the end of a string. The faster it goes, the heavier it seems. You have the same effect on your canopy in a toggle turn. As the canopy turns, the pilot's body continues in a straight line until the canopy pulls him to the new heading. If the turn continues, centrifugal force continues to keep the pilot swung out from under the canopy. When the turn stops, the suspended weight then swings back under the canopy. This transition from the "swung out" position to back under the canopy is the moment when the greatest speed is reached. The canopy reaches top speed because of an increase in wing loading as well as the speed garnered from an increase in descent rate. The faster you turn the more weight appears to be under the canopy. We can think of this as apparent or induced weight, as opposed to simple suspended weight.

Note that in some maneuvers you can actually reduce wing loading for a moment. On many canopies the pilot can create a turn that flings his body up while the canopy turns down and for a moment the lines will actually get a little slack - meaning the wing loading has decreased to almost nothing for that point in time.

Up to a point, more weight (thrust) under a parachute enhances performance. Thinking back to our sled analogy, adding weight to the sled will make it go faster up to the point where it begins to sink into the snow or break up. Without sufficient wing loading canopies become sluggish, while increasing the wing loading enhances speed. Since lift increases with the square of the speed, a wing going thirty miles per hour produces four times the lift of one going fifteen miles per hour. That's why a jet airplane can be supported by wings tiny in proportion to a Cessna's, and why people with the proper training can jump relatively small canopies loaded to 1.4 or higher - some are experimenting with wing loadings of 2 or more! The enhanced performance that comes with high wing loading is not only experienced in straight ahead speed, but in turn rate, flare, and overall responsiveness. But everything has its price. The price of high wing loading is seen later, when we discuss flying in the real skydiving environment.

Center of Mass, Center of Lift

The center of lift is a point on the wing where the lift can be thought of as concentrated. The center of mass is where the weight of the system is focused. On a sport parachute the weight is clearly centered well below the wing, in the form of the pilot. By changing the relative position of the center of mass to the center of lift, the pitch of the canopy can be affected, changing the angle of attack.

Angle of Attack

Many skydivers think angle of attack means the angle of the parachute relative to the ground. Not at all! Angle of attack is the angle of the chord line to the apparent wind. Changing the angle of attack is done by applying leverage against the wing. An aircraft does this with its tail section but parachutes lack this capability. Flaring is the only way to make a change in a canopy's angle of attack. In a flare, as brakes are applied the weight suspended under the canopy (that's you, the pilot) swings forward because the light, high drag parachute slows down faster than the heavy, low drag pilot. The result is that the angle of attack temporarily increases, generating more lift through greater deflection of air.

Note that in a flare, the changed angle of attack is due to an actual change in the apparent wind felt by the canopy as the weight below it swings forward - a lever action against the wing just like a hang glider flare. Toggle action changing the shape of the canopy does make a contribution, but if the weight swing does not occur the angle of attack does not change significantly and only a little additional lift is produced by the increased camber of the canopy. A deep brakes accuracy approach is the typical example of a landing using brakes but not a flare. In a good flare, a steady application of brakes causes the canopy to go slower and slower; the pilot remains slightly ahead of the normal position under the canopy, retaining the increased angle of attack and increased deflection of air. Once all of the canopy's speed is used up, the pilot swings back to normal position. At that point there is no speed left to produce lift of either type, and a high rate of descent begins until the canopy regains speed or the ground interrupts the flight.

You may have noticed I use the term "apparent wind" instead of the frequently heard "relative wind." Apparent wind is a common term in sailing. It refers to the wind the sail feels as it passes through the air. The operator often forgets the apparent wind, confused by familiar but useless references such as the horizon. But the foil knows no horizon, only apparent wind. To visualize this principle clearly, think of a drag plane. People who see this formation for the first time often wonder why the bottom canopy stays inflated. But the apparent wind that the canopy feels is much the same as in normal flight. Just because it is upside down doesn't mean it won't pressurize and produce lift - it just means the lift is down.

Angle of Incidence

Now let's look at angle of incidence, often mistaken for angle of attack. The angle of incidence can be thought of as the trim (nose up or nose down) of the canopy and is built into the parachute by the length of the suspension lines. It can be altered by using either front or rear riser input. Pulling down front risers changes the angle of incidence, not the angle of attack. At the steeper angle, the canopy will descend faster but the apparent wind striking the foil remains fairly constant, although it will shift momentarily as the maneuver begins and ends. With most canopies, the trim of the suspension lines results in a tilt where the canopy slides about three feet forward for every one it slides down - a 3 to 1 glide ratio. Flatter trim will let a canopy fly further, but the penalty is that the canopy is not pressurized as well as a more steeply trimmed canopy, resulting in a foil more vulnerable to turbulence. Steeper trim increases descent rate and pressurization but sacrifices glide, and some flare capability is lost.

Camber

When you pull the toggles down, you change not only the angle of attack, but the shape of the wing itself. Camber refers to the amount of curve across the top of the wing. Wings with a lot of camber generate a lot of lift at slow speeds but create a lot of form drag. If you pull the brakes down and hold them steady, this change in camber will affect how your parachute flies. The descent rate will decrease. So will the forward speed. Modern canopies generally get so much of their flare from angle of attack that your best flare will be from full glide. The high descent speed translates into lift when the canopy is flared. But in situations where you want to slow your descent for an extended period, increasing the wing camber by applying brakes is a very effective way to accomplish this.

Summary

Take a minute some day to watch rocks in a fast moving stream. The smooth, round rocks will have a clear layer of water flowing over them with very little turbulence until the water reaches the down stream side of the rock. That smooth flow over the rock is like the lifting air over the top of your canopy. The turbulent water behind the rock is form drag, the wake your canopy leaves behind as it cleaves through the air. Moss, irregularities in the surface, and roughness at the upstream edge is parasite drag - you can see it. Now look at a jagged rock. Flow separation is written all over it, all rough water and no smooth layer. No smooth flow, no lift. No lift, no control.

As you drive down the highway, put your hand out of the window. Find neutral. Angle it up, angle it down... deflection.

How do these abstract ideas about fluids and foil apply to the day to day skydive? We'll look at that soon. But before we do, let's take a look at the different canopy designs on the drop zone so we can understand why they are built the way they are, and what we can expect them to do.

Chapter Two: DESIGN PARAMETERS

Individual canopies can be described in terms of wing shape, trim and loading. The designer determines the first two, the jumper the latter. Choices on these items determine the way a particular parachute flies, so without even jumping a canopy you can deduce to a great extent how it will fly if you understand these features. Wing shape is defined by aspect ratio and airfoil section. Aspect ratio is the ratio between span (side to side width) and chord (front to back.) Airfoil section can be thought of as the ratio of the wing's height to its chord. Trim is adjusting the particular wing shape to the apparent wind to gain the best compromise in performance characteristics. And wing loading is the choice of how much power the pilot decides to give to the system.

Aspect Ratio

In theory, high aspect ratio canopies fly faster because the higher the aspect ratio, the lower the form drag for the amount of lift produced. In other words, a 200 square foot nine cell produces more lift than a 200 square foot seven cell for the same amount of form drag. Why not build a 200 square foot eleven cell at a very high aspect ratio?

The practical limits of aspect ratio are reached at about 3 to 1. At this point, a designer runs into several problems. Unlike an airplane wing, a parachute has no solid structure but maintains its shape through air pressure. To fly well the canopy must maintain good internal pressure in every cell. The higher the aspect ratio, the more difficult it is to pressurize the end cells. The wing needs to maintain a clean shape, too, which means more lines and ribs. But these mean more drag.

High aspect ratio canopies have a shorter control (toggle) stroke and therefore react more sharply. They tend to stall more sharply and inflate more unevenly than low aspect ratio canopies. Although it takes longer to initiate a turn on a high aspect ratio canopy, once the turn is under way it will be at a higher rate than a low aspect ratio canopy of the same surface area. Finally, more parts (cells, ribs, and lines) found in a high aspect ratio canopy means more pack volume for the wing area.

Between pressurization, diminishing returns on drag, and managing deployment of the canopy, the highest aspect ratio canopies on the market have never passed about three to one. Most nine cell canopies approach three to one; most seven cell canopies fall in the 2.2 to 1 range. Which is better? Everything has its price. A nine cell should fly faster than a seven cell because of less form drag – but it has 20% more lines, ribs, and cell openings than a seven cell - all contributing parasite drag. Throughout the 1990s prevailing wisdom has been that nine cell canopies also have better glide than seven cells. But the definite speed and glide advantages shown by nine cell canopies in the past decade may be largely a function of different foil sections and trim angles combined with more efficient construction. Time will tell; as designs improve seven cells seem to be catching up to nine cells in many aspects of performance but we can still expect high aspect ratio canopies to have more efficient gliding characteristics.

Because they tend to have more predictable inflation and stall characteristics, virtually all reserves are seven cells. So are canopies specialized for accuracy landings, canopy relative work, or fixed object jumping - applications where opening and slow speed flight characteristics are more important than speed and glide.

Foil Section

The foil section of a canopy is defined by the shape of the ribs - a "side view" of the canopy. Generally speaking a slow flying wing must have a thick foil in order to produce lift. (The reason for this is in chapter one but you will have to think about it!) The penalty is that a thick foil has more drag than a thin one. An accuracy or CRW canopy might have a foil section of 15 to 18% of the chord, while a high performance RW canopy might only have a 10% section. Although the thinner section flies faster, it has less lifting ability at slow speeds and will have more abrupt stalls and turns. The actual curve of the foil is also important. If the center of lift of the foil is far forward, the canopy will have a high descent rate and very solid pressurization. Putting the center of lift further towards the center of the chord creates a flatter glide but makes it harder to pressurize the canopy.

Combining this type of foil with a high aspect ratio will cause the leading edge corners to collapse in turns. Elliptical canopies are designed to address this problem: sweeping the leading edge back and reducing the size of the outer cells seems to increase the pressure in the end cells. As an added benefit, ellipticals feel the effects of a steering input more (proportionally more of the outside section of the wing affected by toggle input) giving very snappy response.

Summary

Here are some general guidelines about airfoil design, given a seven cell and a nine cell canopy of the same surface area.

The seven cell is more likely to open on heading, will pack slightly smaller for the same wing area, and is less vulnerable to malfunctions of a line-over type. In a partial malfunction situation, the seven cell will be less radical (have a slower descent rate and less violent behavior.)

A nine cell will have a flatter glide, giving it slightly more range. It will have a longer flare, which may make the flare easier to time but requires a longer runway.

The seven cell will be more stable at slow speeds, give more warning before stalling, and recover from a stall more predictably than a nine cell.

The nine cell may have more forward speed, an advantage in winds.

Wing Loading

This term refers to the amount of weight a parachute is carrying and this is probably the single most important factor in how a modern parachute flies. In the U.S. wing loading is expressed as a ratio of pounds per square foot. For pounds, use your exit weight: combine the weight of your body and all of your equipment. For square footage, use the manufacturer's figure. Then divide the weight by the square footage for the wing loading. For example, I weigh 190 pounds and my equipment weighs another 25, including main, reserve, container, jumpsuit, and paraphernalia. That makes my exit weight 215 pounds. If I am jumping a 205 square foot canopy, my wing loading is 1.05. A student my size under a Manta (288 sq. ft.) would have a wing loading of .75. Someone my size under a Sabre 150 would have a wing loading of 1.43. Most manufacturers will have a suggested maximum wing loading for various designs; many also suggest a minimum.

As a rule, the higher the wing loading, the higher the performance. At very low wing loadings, canopies are sluggish and unresponsive. Increasing wing loading increases forward speed and descent speed. This increased speed gives you a higher turn rate, and the controls will feel more sensitive. Keeping in mind that lift increases with speed, a high wing loading can mean that you get a longer flare than you would with a low wing loading. But since everything happens faster, your room for error is reduced. Partial malfunctions will be more severe with an increase in wing loading.

There is a point of diminishing returns with wing loading. Using an airspeed indicator and variometer (a device to measure descent rate) to test a variety of modern canopies, I found that at wing loadings above 1.5 the only performance increase is in turn rate and responsiveness. As more weight is added, the canopy loses glide (comes down faster) with no gain in forward speed. For general canopy flying, loadings above about 1.4 seem to confer zero benefit to speed and glide while increasing descent rate. Stall speed (the point at which flow separation occurs) also goes up as the wing loading increases.

Here are some general guidelines about wing loading given canopies currently on the market in 1997:

For slow, soft landings, or for jumping at higher elevations, choose a low wing loading: .7 to .9.

For a good compromise of performance and safety, jump a 1 to 1 wing loading; one square foot of canopy for each pound of exit weight.

For a fast canopy, jump at a wing loading of 1.1 to 1.3. Any wing loading over 1.3 puts you in the experimental category, where the canopy is at the edge of its performance envelope.

Experts routinely jump at wing loadings of 1.4 to 1.6 - but they are jumping in the same conditions, every day. Changing landing areas, altitude, or other factors make these wing loadings questionable. As a rule, zero porosity canopies and 9 cells can be safely flown at higher wing loadings than F-111 seven cells. A skydiver who might jump an older seven cell at a .8 wing loading could, with a little training, safely jump a modern zero porosity 9 cell at 1.1.

Trim

How a parachute is trimmed and tuned has a great effect on its performance. Trim refers to the angle at which the parachute is set to descend - the angle of incidence. Nose down trim results in a higher descent rate and increases stability. Nose up provides more glide but makes the canopy less resistant to turbulence or deformation and such a canopy will also take longer to re-inflate once collapsed.

Typically, Accuracy and CRW canopies are trimmed nose down (steep angle of incidence) while RW canopies have a flatter trim. Trim affects the flare in the same way it affects glide. A canopy with a steep angle of incidence will not flare very long, but the canopy will be more stable in brakes and recover from stalls faster. Steering line trim also affects canopy performance. Having the steering lines too long diminishes the effectiveness of control input and might mean the jumper is not getting the full potential out of the parachute at flare time. If the lines are too short, the canopy will always be in partial brakes and will be easy to flare past the stall point. Just moving the point where the toggle is tied to the steering line an inch up or down can make a big difference in your parachute's flare characteristics.

If you have trouble slowing the parachute down on a calm day, chances are your toggles are too low.

If your canopy rocks behind you on landing and is easy to stall, you may need to lengthen your steering lines.

Trim isn't always controlled by the manufacturer. Over time, lines stretch and wear. On higher performance canopies, an inch or two either way makes a big difference. Canopies need to have the lines replaced periodically as they come out of trim. Yet the same skydivers who would meticulously change oil or replace tires on their car may never think about how their canopy holds up over time.

Parachute Materials

The standard parachute nylon throughout the '80s and early '90s was F-111, after the designation given to it by the mill that produces it. Lately coated fabrics, commonly referred to as "zero-p" fabrics, are taking over the market. F-111 is less expensive and easier to work than zero porosity fabrics, which means parachutes of this material are cheaper. They are also easier to pack because air escapes from this fabric more easily than from zero-p. However, they wear out sooner. An F-111 canopy is at its prime for about 300 jumps, will work well for another 300, and will have lost a lot (20% or more) of its original performance by the time it reaches the last 300. Few F-111 canopies are any good after 1,000 jumps.

Zero porosity fabric is more expensive and harder to work with than F-111, so canopies made from it are more expensive. However, the expense is offset by several advantages. Zero-p canopies hold their shape better and less air passes through the fabric, giving them better flight characteristics than a similar canopy built of F-111. They also last much longer, and zero-p canopies may still fly well after 1,000 jumps. They have the disadvantage of being more difficult to pack - until you get used to them, which only takes a couple dozen pack jobs.

Some canopies combine the two fabric types for the best of both. These seem to work well.

Canopy Material	Advantages	Disadvantages
F-111:	Cheap	Easy to Pack Less Aerodynamically Efficient Good for only 600 - 700 jumps
Zero-P:	More Aerodynamically Efficient More Durable	More Expensive Harder to Pack

Parachute Lines

There are two basic types of parachute line, regular dacron line (the thick type) and microline or spectra (the thin type.) Microline is more expensive than dacron, adding to the cost of the parachute.

However, since it is significantly smaller, it reduces drag, giving perhaps a 5% performance increase over a canopy equipped with regular line. Microline is very strong and does not stretch much when weight is applied, as dacron lines do. This means that it tends to cause harder opening shocks. It may also shrink unevenly over time, causing a canopy to get out of trim. Some people find it slightly harder to handle and stow, and it is inappropriate for canopy relative work.

Line Material	Advantages	Disadvantages
Dacron:	Easy to pack Soft Openings	Bulky More drag
Microline:	Low drag Small pack volume	More expensive Harder openings

Other Modifications

Most skydiving equipment comes in a fairly stock configuration, but there are a number of small modifications you can make to the risers and canopy to improve flight characteristics. Not all of them are useful for everyone, but by customizing your gear you can get as much as a fifteen percent performance increase. Enhancements come in two forms; those that reduce drag and those that improve handling.

Reducing parasite drag has obvious benefits because by increasing speed you increase the lift your canopy produces without adding any weight to the system. The most common ways to do this are removable sliders, collapsible pilot chutes, and riser modifications. All of these are fairly simple modifications you can usually order from a dealer or have made for you by a capable rigger. But since they do require a little knowledge to use safely, be sure to get advice and instruction from someone familiar with the modification.

Slider Modifications

A slider is essential to deployment but serves no purpose once the canopy is open. From there on, it is just a burden to the canopy. If you think the drag is negligible, drive down the road at 25 mph holding your slider open. Getting rid of the slider provides another benefit by letting the canopy spread out more towards its original ideal design shape, reducing some of the anhedral of the parachute and giving a slightly flatter flight. Removing the slider not only increases a canopy's performance, it confers aesthetic benefits too by eliminating a lot of noise and greatly improving the view.

There are a number of ways people have dealt with the slider. Each has pros and cons. On every system, the biggest con is that you have to deal with your slider after opening. Remember that stowing your slider is not nearly as important as managing your flight - other traffic and the spot - so never mess around with your slider until you have a safe path back to the dz picked out!

The most common way to eliminate the slider is to pull it down and stow it under your chin or under a velcro strap on the neck of your jumpsuit. The good part of this method is that it is a very simple system in that it does not add significant time to packing and can't be screwed up at packing time. However, it doesn't work if you have thick risers instead of mini risers. If you pull it under your chin, it can blow loose and block your vision. If you wrap somebody or induce a malfunction after stowing it behind your neck, when you cut away your canopy might stay with you! Both the latter cons have occurred with disastrous results. Finally, do not put bigger grommets on your slider to ease the pull down unless you put correspondingly big stops on your canopy's stabilizers or you will get an exciting malfunction!

Fairly common is to leave the slider in place but collapse it with a drawstring. Actually, all this does is silence it a little and reduce some drag, so although this is the simplest possible solution to the slider, it is also the least effective.

Splitting the slider is common with accuracy canopies because it allows the canopy to spread out, it works with big risers and is fairly simple to use. This method is fine for slow canopies because the slight drag from the split slider isn't as much of a factor on an accuracy canopy - they have drag all over them anyway. Aesthetically, split sliders are rather ugly.

Removing the slider altogether is the final option. Removable sliders use a loop and pin system, kind of like a tiny toggle stow, that holds the grommets onto the fabric. To remove the slider you grab a loop in the middle of the slider where lanyards from the four corners come together. A quick tug and the fabric is loose in your hand. You then have to stow the slider in your jumpsuit or some other place where you won't lose it. The grommets of the slider remain at the top of the risers. Before packing you re-attach the slider, which adds a minute or two

to the packing process. Because you definitely do not want to hook it up wrong, it is important to pay attention to the re-attachment.

Collapsible Pilot Chutes

Collapsible pilot chutes are another easy after market feature to add to your parachute. There are two types. Bungee collapsed pilot chutes are simple in that they do not need to be "cocked" to work, as kill line collapsibles do. Their disadvantage is that if the bungee is worn out or when deploying at slow air speeds, they can fail to inflate and cause a pilot chute in tow. Kill line types are the opposite – they work well in most deployment conditions, but if they aren't cocked before packing, you get a pilot chute in tow. As long as you understand and properly maintain the type you have, there should be no problems.

Both types have a somewhat bulkier, stiffer bridle than non-collapsible types. This may increase the probability of tying a knot in the pilot chute as it is inserted in the pocket. I have seen this problem several times and there seems to be a high correlation with collapsible pilot chutes, so be very careful about the packing technique you use.

Riser Modifications

Being able to steer with your front risers adds considerably to your piloting options, yet a stock riser can be hard to grip. Furthermore, as you turn the tension on the riser increases with the weight increase induced by centrifugal force. Therefore, most advanced canopy pilots have some kind of hand hold added to their risers. These usually come in the form of loops or blocks.

Front riser loops are loops of webbing sewn to the riser. Blocks are a stiffener of some kind, usually folded webbing or a metal ring, that is placed just below where your hand grabs the riser. The block keeps the riser from sliding through your hand when you pull on the riser. The advantage to loops is that they have little bulk and won't catch on anything during deployment. However, you have to actually get your hand in and out of them. Blocks are simpler: you just grab the riser and close your hand around it. Open your hand, and you are free of the riser. For this reason canopy relative workers have a preference for blocks, as do many advanced canopy pilots.

Some pilots of small, high aspect ratio canopies have three risers instead of two. The third riser is for the steering line. This modification, like a removable slider, allows the canopy to flatten out, improving the shape and therefore the performance. The fact that third risers are uncommon may indicate that the increased performance may not be worth the increased complexity.

A final modification seen on a few canopies is trim tabs. These allow the pilot to mechanically lock in a certain amount of front riser trim. Trim tabs were fairly common on CRW canopies in the early and mid 80's but are now rarely seen. They add some bulk to the riser but are only occasionally of any use.

Chapter Three: ENVIRONMENT

Weather

The environment in which you fly your parachute includes a large number of variables, any one of which can contribute to an accident. Let's look at some of the many things that affect your canopy.

Turbulence

Turbulence can be described as a disturbance in the air. Several things can cause turbulence that can affect a canopy in flight. Among them are wind, heat and wake turbulence.

Wind over an uneven surface or a temperature gradient creates turbulence. The amount of turbulence increases geometrically with the wind speed. In other words, a building that creates negligible turbulence in a 10 mile an hour wind can create extremely dangerous turbulence in a 20 mile an hour wind. Turbulence extends far downwind of an obstacle. Visualize the wind as flowing water. A line of trees or a long building will have a definite downward wave behind it. A single obstacle such as a building will have both sideways and downward turbulence. For a graphic demonstration, stand behind a large building on a windy day and note which way the wind currents are where you stand. Odds are they will be quite different from the general wind direction.

Dust devils are caused when a small area of air is heated above the temperature of the surrounding air. These miniature tornadoes create severe turbulence in an area up to a hundred or more yards wide. They can easily

collapse all or part of a canopy. They can also cause downwind landings, either by causing a false reading on wind indicators or by changing the wind direction in their immediate area.

Wake turbulence is a common cause of hard landings in a crowded landing zone. A canopy's passage through the air leaves a wake similar to the one behind a boat. The wake has two characteristics. One is general turbulence directly behind a canopy that can drastically increase the descent rate of a parachute flying through it. This occurs because the "bumpy" air reduces the lifting force of the canopy by disturbing the airflow over the wing. The other wake turbulence is from "tip vortices," which spiral out from the edges of the canopy. These occur because air tries to move from the high pressure bottom skin to the low pressure top skin. It takes the path of least resistance, which is towards the sides of the canopy. As it spills off the end cells it creates a circular wake trailing behind each wing tip - just imagine the V shaped wave behind a power boat. These are essentially miniature dust devils and can easily collapse an end cell or two. Both types of wake turbulence extend well behind the canopy - as much as fifty feet or more - before becoming insignificant. An interesting exercise is to open high with a friend and intentionally fly through their canopy wake to get an idea of how your parachute handles turbulence.

Last but not least, don't land behind the airplanes when the engines are running!

Density altitude

Thin air reduces a wing's performance. Two things cause air pressure to drop: heat and altitude. Therefore, you can expect that a canopy that performs well at sea level on a cool day will fly significantly worse at high altitude on a hot day. As a rule of thumb, count on a 3 to 4 percent performance loss for each 1,000 foot elevation gain or each 10 degrees temperature increase. Using this rule of thumb, a parachute taken from sea level to a 3,000 foot high dz would lose about 10% of its efficiency if the temperature remained constant. Or, jumped at the same sea level dz on a 70 degree day and a 100 degree day it would show a comparable change in performance. Humidity also decreases performance slightly.

Traffic

At a large drop zone it is not uncommon for twenty or more skydivers to share the landing area. As more and more of these jumpers use fast canopies, traffic becomes a real hazard. We all know that auto traffic follows certain universal guidelines to minimize collisions. The same is true of aircraft and boats, and even in the freefall portion of skydiving. Yet for some reason, skydivers have been reluctant to adopt standard traffic patterns under canopy even though this simple idea could prevent several injuries and fatalities annually. By following some simple guidelines, you can be a good citizen in the skydiving community, minimizing risk to yourself and others while still having fun.

Break-off and Deployment

Traffic management actually begins at the dirt dive. Be sure you plan a break off altitude that will allow plenty of time to get away from others and still be open by at least 2,000 feet. USPA's Basic Safety Requirements specify container opening by 2,500 feet for intermediate level jumpers (A and B license) and 2,000 feet for advanced jumpers (C and D license.) The custom for many years has been to break off at 3,500 for small RW groups and USPA recommends 4,000 feet for groups of six or more. But in the modern canopy environment, we should reconsider these numbers. The advent of "fast" canopies has had two effects on the break off and deployment section of the skydive. One is the issue of how much separation from other canopies is enough. The other is how much time a jumper might want to deal with a malfunction on a modern canopy.

At Skydive Arizona, canopy collisions at the deployment phase cause one third of fatalities - more than any other type of accident. To minimize risk skydivers need to minimize the causes of these collisions: off heading openings and inadequate separation. In an ideal world where canopies would always open on heading it would suffice for everyone to turn away from the center and deploy. We'll discuss controlling the openings later, but right now, let's talk about the real world of canopies that occasionally open off heading. That's when adequate separation becomes essential.

How much separation is enough? Typical modern canopies fly forward at about 35 feet per second while the brakes are still set in deployment configuration. When facing another canopy as a result of off heading openings the closing speed can be up to 70 feet per second. With brakes off, it is more like 90 feet per second. Given that it will take about three seconds to recognize the emergency and begin appropriate action, deploying within 200 feet of another skydiver is very hazardous. A good skydiver can attain speeds of 80 to 90 feet per second in a track - but it takes time to turn, build up speed and then wave off and slow down the track. To turn 180 from the formation, begin a track, sustain a good track for at least three seconds, and then wave off is the work of at least eight seconds - 1,500 feet of altitude at the minimum. That means that if you want to initiate

deployment at or above 2,500 feet, you need to break off at or above 4,000 feet. More tracking time means a higher break off.

Although details on tracking skills fall outside the scope of a treatise on canopy control the collisions that might result from poor break offs are part of the subject. Learn how to "flat track" from an experienced RW jumper - just watch the break offs from the ground and you will be able to figure out who has mastered the technique. But there is much more to separation than how effectively you can track. An important thing to keep in mind is that the fundamental goal of break off is to deploy your parachute in clear airspace - not necessarily the same as being able to track fast and far.

For example, if two skydivers find themselves tracking in roughly the same direction at 4,000 feet, they have a traffic problem. If both continue to track, at 2,000 feet they will have the same traffic problem and no altitude in which to fix it. In this situation, the higher (or further behind) skydiver should wave off and deploy as soon as he knows there is no one above, behind, or deploying to the side. Similarly, it makes sense to have one person pull in place (customarily the video man, if there is one) while the others track away from the center person.

Separation is one way to minimize the risk of collisions. Controlling the deployment is another. Most off heading openings, line twists or snivels are caused by either packing or body position. Be sure to pack as symmetrically as possible. Since this discussion is on canopy flight, not packing, you will need to get this information elsewhere. BASE jumpers and canopy formation enthusiasts are good sources for packing tips that will contribute to on heading openings.

Body position is as crucial as packing technique. To understand this, next time you are under canopy raise your right knee as high as you can and twist your shoulders to the left. You should notice a left turn (assuming your canopy flies straight in normal flight!) The turn will be more pronounced on higher performance canopies. Now imagine how much more air is affecting your canopy during the deployment phase, when you have considerably more speed. Having a shoulder down (looking behind is a common cause) can result in off heading openings or line twists. To prevent this, as you track away clear the air to the front, sides and below. Looking behind is largely a waste of time and awareness. Your job is to ensure no one is deploying below you.

When the time comes to deploy, wave off and throw your pilot chute. As you do so, pick a point on the horizon straight ahead. When the canopy deploys, it may have an inclination to turn right or left. Concentrate on holding your shoulders square and towards your heading point. If the canopy turns right, twist your shoulders back towards the heading. As the canopy fully inflates, grab risers or toggles and steer towards your heading. Turning back onto the heading will keep you flying away from others until you have a chance to ensure the space around you is clear.

Traffic management under canopy

Once under canopy, immediately clear your airspace. This means checking for potential collisions before you do anything else. Releasing brakes, stowing sliders and heading for home are all secondary to collision avoidance. If you are faced with a collision, the general rule is to turn right. Practice using front and rear risers for this. Front risers will cause sink, rear risers cause float. Altering descent as well as direction should be practiced until it becomes second nature.

As you head for the dz, there are a couple things you need to check as soon as you have cleared your air and have your canopy in hand. Is anyone under their reserve? If so, go to their aid by following them or their equipment - the main and free bag. Ideally someone will follow each item to ensure recovery. This is your duty to all fellow parachutists, whether you know them or not. Sooner or later you will be under your reserve, watching your main canopy drift away from the dz at sunset. When it happens, you will be glad to have some company.

Assuming all is well your next task is to obtain as much vertical separation from the other skydivers as you can, assess the spot and choose your landing areas. We'll hold off discussion of bad spots until later, while we continue to look at traffic. Assuming you can make it back to the intended landing area, while you are flying along take stock of the other canopies. With practice you will be able to recognize the types, speeds and altitudes of other canopies. Compare them to your own and begin the process of vertical sorting. Low canopies with high descent rates should maintain a fast descent rate to increase separation from higher canopies, while higher canopies should slow their descent.

Regardless of design specifics a typical modern canopy will have a broad range of descent speeds. In full glide most canopies will descend at 1,000 to 1,500 feet per minute. The same canopy in one half to two thirds brakes will descend at 600 to 900 feet per minute. In a turn, it can easily reach descent rates of 2,000 feet per minute. Therefore, most canopies have a range of descent rates of at least 1,500 feet per minute. By taking advantage of this a wise canopy pilot can ensure that of the twenty people he was on the plane with only two or three will be landing at the same time he is. A helpful hint: most people are better at sinking than floating. Learn how to slow your descent rate and you can have the landing area to yourself. The added advantage is that you get to watch everyone else land, giving you extra information about ground winds.

Final Approach

Eventually it will be time to enter the landing pattern. Like the break-off, this is a very dangerous part of the skydive. A good approach is more than aesthetically pleasing - it can be the difference between life and death. What makes for a good traffic pattern? Whether your style is aggressive or conservative, an elegant landing is characterized by these features.

The initial approach is easily understood by other canopy pilots in the air.

The turn on to final approach does not intersect the flight path of other canopies.

The entire approach and landing is done in such a way that it does not cross a straight ahead, conservative approach to the center of the landing area.

The approach is not directly over or next to any bystanders.

Most landing areas will have some buildings, roads, fences or other obstacles that affect the pattern. With airplanes, the convention is to use a left hand pattern - one that uses only left turns onto the different legs of the approach. That makes sense because the pilot sits on the left of the plane and has better visibility that way. With parachutes the situation is different. Some drop zones like a left hand pattern so everyone does the same thing. Some allow either left or right patterns to allow skydivers of different experience levels to split up the landing area and control what obstacles they will have to fly over.

Canopy and pilot types also affect the pattern. Generally I find they can be broken down into two classes: conservative approaches used by novices or other people inclined towards caution, and aggressive approaches used by skydivers with high performance canopies. Since these types may be about equal in numbers, the vertical separation mentioned earlier is critical. Even so, we can expect a few of each category to be landing simultaneously. How do we keep the two incompatible styles safe?

Let's use Skydive Arizona as an example. We allow skydivers to choose either a left or right pattern. Our primary landing area is about 80 meters wide from north to south. On a day when landings are to the west, people using left hand patterns should approach over the buildings and land within 20 meters of the fence. By local custom this pattern is reserved for fast canopies and experienced pilots. They have the skill to land near obstacles, and it keeps them out of the rest of the landing area. People using right hand patterns should land well to the north of the gravel target in the center, leaving that area free for people using a straight in approach.

The less experienced jumpers stay out over open desert and land further away from the fence. Their main concern is to avoid overshooting the landing area and ending up on the asphalt taxi way. But imagine the wind shifting to either the north or the south. Now a new set of problems arises – the danger of undershooting or overshooting the landing area.

In general, overshooting is a problem on calm days; undershooting, windy days. Instead of thinking of landing on a circular target, imagine a runway. Depending on your skill level and canopy type, always give yourself a long enough runway so that whether you land long or short you will not be faced with hitting obstacles or people. Sometimes that will mean picking an alternate landing area with a little more room, since on a calm day most modern canopies need at least a one hundred yard runway to be safe. The dart board style idea of a landing area has become obsolete - always think of a runway!

Finally, we need to consider the combination of traffic and obstacles. Look at our sample landing area again. Let's say the wind is out of the west and you are approaching along the fence. If a canopy on a more southwesterly heading lands in front of you, you have no place to go. Choices are collide with the canopy, collide with the fence, or do a sharp right turn out into any other traffic, with the hazards of wake turbulence and low turns thrown in. Many canopy pilots develop the habit of thinking of a certain area as "theirs." If you find someone in "your" airspace, what will you do? Learn to maintain a flexible approach!

Low speed approaches have their own set of problems. Using deep brakes or "S" turns in a crowded landing area is as dangerous as "hook" turns. Do not employ student flying techniques in an area for advanced jumpers.

Regardless of your personal style, the etiquette is:

Low man (including people on the ground) has the right of way, as do students and tandems. Never use an approach that will force traffic behind you to use evasive action or fly through your wake. Don't intentionally land crosswind or downwind: This not only presents a huge traffic hazard, but leads everyone still in the air into a state of confusion.

Any discussion of landing areas needs to address so called "hook" turns. I dislike this term; to me a hook turn is a low toggle turn, not necessarily intentional, that shows a lack of planning or respect for the surroundings. High performance landings are another thing altogether. It is acceptable to blend the turns onto crosswind and final into a single, smooth, carving 180 if it is "round" enough to allow you to alter it in the event of traffic conflict and is intelligible to others as a transition through the customary downwind, crosswind and final approach. A detailed discussion of good high performance technique will follow in the chapter on flying skills.

Just as there are some things that define exemplary landings, there are some that define unacceptable technique. Some common approach errors that are rude or dangerous are:

- 1) *Downwind approaches over the center of the landing area. In this situation, no one in the air knows which way you intend to turn. For all practical purposes you are obstructing the entire landing area. In addition, you are putting yourself in a situation with no escape routes - if traffic eliminates your intended turn you will be forced to land downwind or execute your turn too low. Therefore, all downwind legs of the approach must avoid flying over the center of the landing area.*
- 2) *Sudden, "snap" turns, especially more than 90 degrees. These turns have several problems. From the standpoint of other traffic, they do not allow you a good view of where you will be going and greatly increase the possibility of a collision. They are also confusing to other canopy pilots.*
- 3) *Approaches that may cause you to land crosswind/cross traffic Due to traffic, obstacles, turning too low, or other factors.*
- 4) *Approaches that cross through some or all of the normal straight in approach pattern. Imagine a line along the wind through the center of the target. No approach should cross this line. If you use a left hand approach, finish on the left side of the line. If you use a right hand approach, stay on the right side of the line.*
- 5) *Final approaches that put the pilot over or next to bystanders. Always remember that many skydivers have poor hearing and may not know where you are if they don't see you. Whuffos have no idea where parachutes will go. Never assume they will stay in place - or move - if you need them to. While striking people on the ground is rare, it should be considered as reprehensible as a motorist striking a pedestrian.*

The final aspect of controlling the landing area takes place after you land. Collapse your canopy quickly so no one will hit it. Leave the area promptly; you can discuss the dive somewhere other than an active landing area. In particular avoid the area downwind of obvious landing spots such as the pea gravel. This is where incoming canopies will tend to concentrate. If you are in the pea gravel assume someone is right behind you and clear the area at once. As you depart the landing area, scan constantly for incoming canopies: never assume they see you or that they are in control.

Chapter Four: GETTING THE MOST OUT OF YOUR CANOPY

If you watch a busy landing area for a while, it becomes obvious that some skydivers are masters of their canopy. They land gracefully and safely where they want to, every time. It looks effortless. Others do well sometimes, but often seem to be on the verge of losing control. Still others are clearly either novices or intimidated by their canopy - their landings lack precision and grace. And the parachutes aren't the deciding factor. Look closely; some of the best landings will be on older, well worn canopies, while the finest new equipment can be dangerous in the wrong hands.

The difference is in the pilots. The good ones have an intuitive understanding of aerodynamics and the experience to completely control their environment. And over the years, experimentation has taught them some practical techniques to get the most from their parachutes.

The Spot and the Winds

In the previous chapter we looked at the problem of airspace management without taking the spot into consideration. If you are jumping from a large airplane, or from a small one with a bad spotter, your opening point may be less than ideal. But there is a lot you can do about this under canopy. By learning a few tricks about canopy flight, you can optimize early in the ride where, when, and how you will land.

First of all, keep in mind that altitude is your friend. The more altitude you have, the more options you have. This is another good reason not to pull low. Under an open canopy at 2,500 feet you have forty percent more options than someone in the same spot open at 1,500. This means more time to acquire vertical canopy separation, more time to assess the wind conditions, and if necessary, more alternate landing areas to pick from.

Your first priority after a successful deployment is to avoid collisions. Once that is done, determine where you are and head for the dz. You will already have this information if you checked the spot during exit or freefall; now you need to decide what to do with the knowledge. Incidentally, I often see people land out because once they were open they stowed their slider, removed booties, or did some other trivial task while flying away from the dz! These things can be done just as easily flying towards the landing area instead of away from it.

Depending on the circumstances you will be in a perfect spot (which we won't consider here) or one of three variations of a not so perfect one: long, short, or off the wind line. In each of these cases there are certain strategies that will help you out. And in all of them your best plan will be influenced by the amount of ambient wind. On a no wind day the plan is the same regardless of position: for the greatest range, trim your canopy for distance. Most parachutes fly flatter, and just as fast, if you hold in a couple inches of rear risers or about one third brakes.

Optimizing Glide

Finding your best glide position takes a little work. A variometer and airspeed indicator designed for hang gliding is ideal, but observation works too. Try flying next to a similar canopy and applying brakes or rear riser trim to flatten your glide. You will notice that you can flatten the glide quite a bit before you lose much forward speed. Another trick that you can use by yourself and which will come in handy often is to learn to visualize your glide. To do this, watch the ground ahead of you. Looking at a point far ahead, you will notice that point will appear to rise relative to you. That means you will land short of the point. Look just a little ahead - the point will sink relative to you, since you will pass it in flight. Somewhere between will be a point that doesn't move - where you will land if nothing changes. (Illustration maybe including into wind and downwind variations.)

With practice, you will be able to identify this point quickly. Once you can do so, whether you are facing into the wind or running with it, you can check and see what your best glide is. Generally, when facing into a strong wind you want a steep angle of descent for the greatest forward speed and the least amount of time at the wind's mercy. Full drive (toggles all the way up) will produce the best results when you are trying to penetrate into a strong wind. Front riser input is even better, but few people have the strength to hold down their risers for long.

If you are upwind and have a little breeze to work with, the reverse will be true. In this situation, apply brakes to get your slowest descent rate. Most modern canopies reach their slowest descent in about 50% brakes. You might lose some air speed, but you will gain distance. Why? Let's say your canopy descends at 1,200 feet a minute in full drive but only 800 feet a minute in half brakes. If you are open at 2,400 feet, that means a two

minute ride in full drive but three minutes in half brakes. Now, say the canopy will fly 30 miles per hour in full drive, 20 in half brakes. Add a ten mile an hour wind and your ground speed will be 40 and 30 miles per hour, respectively. In two minutes at 40 mph you will cover about 7,200 horizontal feet. In three minutes at 30 miles per hour, you will cover about 8,100 horizontal feet - quite a gain! Therefore, whenever you are spotted long upwind, you are better off using some amount of brakes. How much will depend on the particular canopy, winds and spot.

Spots that are off the wind line are also common. In this situation, don't fly directly towards the dz. If you do so, your canopy flight will take the shape of an arc across the ground as the wind pushes you sideways while you fly forward, constantly changing heading to stay pointed at the target. Instead, take an angle that points upwind of the landing area and again watch your path over the ground. If your ground path is a straight line to the landing area, you are doing fine. If it is curving ahead of you, you are crabbing too much. If the curve sags behind you, you aren't crabbing enough.

Landing Out

Sometimes the spot is so bad all the piloting technique in the world can't salvage it. Landing out is a fact of life. It is also a common factor in landing injuries: an out landing may involve a tight landing zone, no wind indicators, unforeseen hazards, or all of the above. If there is any possibility of landing out, start making your plans up high! In fact, the time to plan for an out landing is before you get in the plane. It is always a good idea to note the prevailing wind direction and speed. Most drop zones will be able to provide an aerial photo showing hazards, good alternate landing areas, hostile neighbors, etc.

If you are landing out and forgot to check the winds earlier, start looking for indicators. Distant fires or dust can help. In areas with lots of foliage, you can sometimes tell by observing grass or trees. If some people are making it back to the dz, watch them: they will be close enough to see the wind sock. You can also look for cloud shadows on the ground. For that matter, your own shadow is a good indicator of ground speed, if you can locate it while high enough for the information to be of any use.

Even if you can't determine wind direction, remember that a crosswind or downwind landing is still much safer than landing in a turn. In fact, one of the more common causes of so called "hook turn" injuries is from unintentional low turns. The scenario is simple: running downwind from a long spot, the pilot doesn't realize until too low they are flying downwind. Then they try to turn into the wind without enough altitude. Most canopies need at least two hundred feet to complete a fast toggle 180 degree turn with a safety margin to spare. Practice turning in half brakes for just this eventuality. A turn in brakes doesn't use nearly as much altitude as a full toggle turn.

Regardless of where you land, you will have a choice of how you approach - either a left or a right hand pattern. Always pick the one that flies over the fewest obstacles and offers the most alternatives. That way, if the wind is stronger than you expected you still have some options.

Common Landing Problems and Their Solutions

Before we look at specific landing problems, here is some general advice. If you have trouble landing your canopy, or you are relatively inexperienced and planning on buying a canopy, have someone your size and weight who really knows what they are doing jump it. They can give you a good idea if the problem is your technique or if it lies in the canopy itself. I also highly recommend video. The common piloting problems discussed below are easily eliminated by one or two video reviews, provided the coach is competent.

Depth perception

We'll get this out of the way at once, since I believe it is the least common problem. Detailed and useful depth perception doesn't occur until we are within fifteen or twenty feet of an object, and in parachute flying this is when we already need to be acting. Furthermore, for novice jumpers there is a timing problem. When your brain finally says "I'm about 15 feet up" it starts an equation based on what would happen if you jump off an object and accelerate constantly till impact OR one based on a steady state descent like the one you are in. It isn't programmed yet for the deceleration you experience as you flare. So depending on your eyes and brain, you might flare high or not flare until too late. This is compounded if there are confusing conditions: twilight, very flat surfaces such as concrete or astroturf, unusual lighting, tilted surfaces (hillsides), unusual vision (jumping without your usual prescription eyewear), and other eye/brain variables. The only solution I know is experience. Have someone who is real good call the flare for you on several jumps, but only if you are not already flaring correctly. See the other problems below before you put all the blame on depth perception.

Usually your brain figures out the depth thing after at most a dozen jumps. Therefore, if you still have trouble flaring it's more likely a technique or equipment problem.

Flaring too high or too low

This is a very common mistake and the way most schools teach a flare only makes it worse.

Instructors commonly teach students to make a single flare motion, knowing that a two stage flare is a bit complicated for a first jumper. And since they don't want the student to flare high, they often tell them to flare fast and low. You can get away with this on huge canopies, but it will hurt you when you transition to something requiring more finesse. Flaring is like applying the brakes on a car. It doesn't need to be done all at once, at the last possible moment.

[DIAGRAM UNDER CONSTRUCTION]

Connect the x's from left to right to complete this diagram of what a canopy does in a good flare. The numbers above the line indicate horizontal speed, and the ones below are vertical speed. This is an example only; student canopies fly slower, low aspect ratio and slow canopies have a shorter flat spot in the flare.

This picture is about what a seven cell at 1 to 1 wing loading would do. Many nine cell canopies have a much longer flat spot in the middle. The faster the canopy goes the longer the flat spot in space, though not necessarily in time. From full glide to about a third to half brakes should take a second or two. Then there is a pause as the canopy remains flat and bleeds off speed. Finally, to keep the descent rate slow continue to apply brakes as needed, keeping the angle of attack up and increasing the "flaps" effect for a better slow speed foil (increased camber). Going from full glide to full brakes as fast as possible cuts out the entire middle half of the flare - one second you're flying fine, the next you are at the edge of a stall as airflow separates from the canopy surface. That's why a very fast flare doesn't work well. The canopy needs a smooth transition to flare effectively.

To pick your flare timing imagine a calm day. Put a sheet of blank paper across the drawing to represent the ground. You can easily see that you would rather land towards the end of the flare, where you have the lowest overall speed - a little down, a little forward. Flare too high (move the paper down) and you have a lot of vertical speed. Flare too low (move the paper up) and you have a lot of horizontal speed. Now imagine a day with a ten mile per hour breeze. Move the "ground" up to the optimal point, which is in early part of the second half of the flare - still some forward speed, very little down. This is why 5 to 10 mph days produce the best landings - you have a long sweet spot. But flare too high, and you will be backing up and descending fast. Don't flare enough, or too low, and even though your forward speed is low you still have a lot of downward speed. That's why even on a windy day you need to flare in order to eliminate the downward component. But the windier it gets, the lower you can flare because you only need the first part, the part that flattens you out, not the one that slows you down.

Hopefully this will show why on windy days the common mistake is to flare too high (the other is to undershoot the target, but accuracy is another topic.) On calm days, people tend to flare too low and overshoot. Perhaps this is because our habits aren't based on living in a fluid environment that varies not just day to day but hour to hour. Sailors, kayakers and pilots are used to the idea of life in a fluid and tend to pick this up quickly. People who have led very static lives have a tough time. The bottom line is that you don't need to learn just one flare, you need to learn half a dozen to cover the basic variations in conditions. To do this, you need to combine experience with an understanding of how a parachute flies.

Too much input

This problem occurs when you are indecisive about flare altitude. As a rule "the more you do with your toggles, the harder you land!" Up and down toggle motions cause you to oscillate below the parachute, making it alternately dive and float. This will also reduce lift since airflow is being disrupted. The net result is an increase in descent rate. Your flight path varies constantly, making the situation even more confusing. You land hard. The only way to fix this is to be decisive. If you flare high, stop. Hold what you have, then finish the flare at the appropriate time. This means if you are in half brakes, don't apply the second half at normal flare height, but somewhat lower - say, waist to head high. Finally, it is easier to speed up a flare than slow it down, so when in doubt, maybe wait an extra second.

Asymmetrical or incomplete flare

There are two manifestations of this problem. The first is that the flare stops at about elbow height. Toggle pressure increases as you go down, so the first half is easy but the last requires quite a bit more strength. No problem on a breezy day, but if you come in hot on calm days it may be that you aren't flaring all the way.

The second manifestation is when one hand comes down further than the other. There are two causes. One is having a weak side, and the other is landing crosswind. Fix the first by shifting your beer cans to the left hand (or whichever is the weak side) when discussing your latest crash and burn after jumping is over. You can also develop the habit of turning with your weak side when you are flying around, to get it more used to the toggle feel.

The crosswind is more subtle. Crosswind landings are actually quite easy, but as you flare you need to keep the canopy flying straight, which means a little extra toggle on the upwind side. Like any technique, this can be practiced. But be aware that you should only practice crosswind landings where it won't confuse others in the pattern. You should be the only one landing when you are working on crosswind technique. Naturally, start with a light breeze rather than a strong wind! The main thing to remember is to look where you want to go, not where you are actually going. By doing so you will automatically keep the canopy flying straight and level.

Whether the asymmetrical flare is caused by a weak side or a crosswind, the effect is the same. As the pilot perceives drift to one side, they usually look down where they are going. This turns the canopy even more that way as the hand on the low side comes down and the shoulders rotate that direction. Often the pilot instinctively reaches out for the fall, making it worse - especially if the other hand is forgotten and comes up, a common action. The moral of the story is always look where you want to go, not where you are going. If the canopy is veering left, look straight and compensate with right toggle.

Mechanical problems

A surprising number of canopies come from the factory unevenly built or poorly tuned. Even more slip out of perfect tune after a few hundred jumps. If your canopy has a built in turn, it probably won't flare too well either. Bad line trim can be just an inch of variation, and it takes a good rigger to find this.

Most factory brake settings are wrong. They are built for the average hypothetical perfect wing loading, with no regard to long or short arms, harness configuration, riser length, actual wing loading and other variables. Generally speaking a canopy will have the factory brake mark about three to five inches too low (done so a heavy guy with real long arms can't stall it easily) which means that the last half of the flare can't be completed. While one or two inches of toggle setting might not seem like much, it is very noticeable when landing on a calm day. Therefore, if you routinely come in too fast on calm days this may be your problem. Experiment first with gripping above the toggle to take out a couple inches of line, then with a wrap around your hands. Once you find a setting that gives you a good flare, move the toggles to that point. Be sure to get a rigger or other knowledgeable person to check the toggle attachment. Having a toggle come loose can be a serious emergency, especially if it happens at flare time!

Some people will tell you that if you move your toggles up too far, you reduce the forward speed of the canopy because it is constantly in slight brakes. You also make it fly less well in front risers due to deformation of the foil. But don't worry too much about this. If you get a better flare and don't fly in risers much anyway, what do you care? We are talking good landings, not the CRW nationals, so use what works for you.

Many canopies are just plain dogs, either because of old design and construction or because of wear. F-111 canopies become very permeable and zero-p parachutes lose their line trim. Don't buy old (over 500 jumps) canopies unless you can't afford anything else. If you are in this economic situation, get one bigger than you would if it was new. Generally, don't assume that your landing problem is pilot error if you are under an old canopy. Check for trim problems and toggle setting. And if you are considering buying a used canopy, get a good pilot of your weight to evaluate it first. Old canopies have a very small zone of forgiveness. If you are looking at one of these, think about what will happen if you step out of that zone. Given the choice, would you prefer to spend money on good gear or medical bills?

Inappropriate transition

If the canopy you are transitioning to is just too different from the one you are used to, you will have trouble figuring it out. That's why a 120-pound jumper who learns on a Manta might have trouble on a PD 170. The canopy size may be appropriate, but the difference in flight may be too great. Similarly, if you are used to nine cell canopies, going to the short flare and steeper glide of a seven cell can be a bit of a surprise.

Conditions

Wake turbulence or obstacle generated turbulence can suck you into the ground hard. Chase someone's canopy up high to get a feel for turbulence, but avoid it down low. Density altitude can also deprive you of performance. A rule of thumb is that you lose about three to four percent of performance for every 10 degrees over 70 and/or every thousand feet of elevation. You just don't notice the loss until faced with a stable reference such as the ground.

Terrain

When landing on a slope, unless there is a lot of wind (10 plus) land across the hill, not up or down hill. It is a good idea to practice crosswind landings for just this sort of eventuality. However, be sure your crosswind training doesn't confuse or conflict with other traffic!

Finally, there are a couple things to do that will improve your performance even if you already land OK. Cross train: mountain bike, run cross country, ski, kayak, drive - anything involving movement and coordination in a rapidly changing environment. Exercise does a lot more than make you stronger; it makes you mentally more agile. The people who land really well seem to be fairly athletic, so maybe there is a connection. And obviously, if something isn't working, don't continue to make the same mistake. In several sports I've taught, people seem to intuitively know that repeating a correct action is good, but they don't always understand that repeating an incorrect action is bad. If you aren't happy with your landings, something is wrong. Something can be fixed. Do it!

CHAPTER 5: HIGH SPEED CANOPY FLYING

During the early nineties advances in materials, design and construction techniques allowed canopy manufacturers to produce a new generation of canopies with previously unheard of durability and speed. Initially these designs were used only by the most advanced skydivers, but in recent years they have become more common among average recreational jumpers. Speed and energy definitely enhance fun potential - but they also greatly increase risk. Unfortunately flying technique, instruction and skydiving customs have not kept up with fast canopies and the sport is paying for it with a big increase in injuries and deaths in which these parachutes are a factor.

Two fundamental truths underlie the risks of fast canopies. One is that kinetic energy increases geometrically with speed. In other words, doubling speed results in a four fold increase in energy. The second is that speed is, essentially, the relationship of distance and time. Doubling speed cuts time or distance in half, leaving a pilot with less time and space in which to consider his options. The bottom line is that using a faster canopy leaves little room for error, while at the same time greatly increasing the penalty for mistakes.

That said, it should still be possible to fly fast parachutes safely. The key is in developing techniques that minimize traffic conflicts and the potential to collide with the ground, obstacles or spectators. Look back at the section in Chapter Three. The sections on obtaining vertical separation are particularly important to anyone planning high speed landings. By minimizing the number of people you share the landing with you minimize your hazards. Furthermore, study the regular jumpers for their tendencies. If you know the flying style of the people you share the sky with it becomes relatively easy to predict their behavior.

The next step is to control the landing area. By this I mean that while still high, you have identified all possible traffic, determined landing direction and considered obstacles and escape routes. I like to do a long crosswind approach since it allows a clear view of the intended landing area and if the crosswind is done over an open area, I can abort the approach to the primary landing area with ease. Never do "S turns" or spirals on the approach if you are sharing the air with other canopies because every turn you make increases the chance of a collision. Unless you are alone, the most predictable and safe pattern is the one airplane pilots use at every airport - downwind, ninety degree turn to crosswind, then ninety degree turn to final.

The Final Turn

Beginning with the first jump course every skydiver is drilled on the concept that a turn close to the ground is one of the leading causes of injury in our sport. Whether such a turn is intentional or not, contact with the ground before the canopy has resumed normal flight often results in serious injury or death. There are essentially two causes of these premature landings. One is an unintentional emergency maneuver, often to avoid a far lesser threat such as a downwind landing. The other is intentionally induced turns. There is no doubt

that the increased speed provided by a turn just prior to landing provides thrilling performance. Since many skydivers seek this particular thrill, they need to be extremely familiar with the effects of turns and the implications of poor judgment. However, even skydivers with no interest in so called "hook turns" still need to know what is involved in order to avoid the consequences of a panic turn. Many of the so-called "hook turn" injuries and fatalities are from unintentional turns. It is also important to distinguish, as we will below, between the out of control hook turn and a controlled high performance landing.

The only safe path to stylish landings is to work your way up slowly, know where to stop, and always be willing to abandon the high performance approach for a more conventional one. For this, of course, you need a canopy that gives this option! One should also recognize that performance is as much a function of piloting as of equipment. Instead of increasing the thrill of canopy flight by moving to a faster design, skydivers should strive to get the maximum performance out of their existing canopy and only move on after they have mastered all aspects of flight on a conservative canopy.

The entry level high performance approach is to use a normal, high toggle turn to put yourself on a straight ahead approach on final, at a comfortable height off the ground. Keeping your toggles securely around your hands, grab your front risers and pull them down about four inches. It will be just like a normal approach, but let the risers up slowly a few feet higher than you would usually flare. Then flare smoothly and slowly at your normal altitude. Initially you will probably initiate and end front riser input too high. Only four or five seconds are needed to reach top speed, so starting too high will wear you out but is otherwise harmless. Ending a little high doesn't do much good either, since your speed bleeds off rapidly. But the important point is that ending high doesn't hurt you either. Ending low will.

There are a few things to watch out for as you begin learning high performance approaches. One is that riser input definitely increases speed. It also increases forward penetration and once you drop the risers your canopy will tend to float. Expect to overshoot your target, so leave some outs! If you have to run out your landings on calm days, either you are flaring too low or your steering lines are out of tune - toggles too low on the lines. Fix this before trying the front riser approach. Finally, whether you choose riser blocks or dive loops, be sure your toggles remain securely in your hands when you grab or release the risers! This should be practiced up high to get the feel of it.

At this point in your progress it is a good idea to have an expert canopy pilot watch a few landings, perhaps with a video camera, and critique your technique. An experienced eye can tell you if you are using too much front riser, if your toggles need to be re-set, if you are flaring unevenly, and other important details.

Once you are to the point where you never under or over shoot your landing or have to alter your approach because of traffic not accounted for early enough, you may want to use a slight front riser turn onto your final approach. Be an honest judge of your performance: if you use variables such as changing winds, traffic, or other conditions to excuse a botched approach, you have not mastered the first two steps: traffic management and control of the landing area environment. Using excuses indicates an unwillingness to take responsibility for inexperience or poor judgment, a mental state that has no business in the world of high speed canopies. The increased speed created by high performance canopy flying is a great hazard to others in the landing area, and therefore carries a heavy weight of responsibility. Under a fast canopy there are no excuses!

Progress by making shallow front riser turns of about 30 to 45 degrees onto your final approach, then transition to both front risers until flare time. A turning front riser approach is a step beyond a straight approach, and probably the most commonly used high performance approach. As with a straight approach, a good front riser turn requires a smooth entry and exit from the maneuver. The initiation of the turn may be steep, but the second half should have a gradual reduction in front riser input. In this situation, the initial steep descent creates speed that is translated into lift as the parachute flattens out. The transition from riser input to toggles should be almost imperceptible.

If at any time you are having to use rapid, aggressive toggle movement to avoid hitting the ground, you are far too low in your turn. "Stabbing" the toggles down is a definite indication of poor control. The best landings involve both a gradual entry and exit from front risers, followed by a smooth, slow flare. A well landed canopy builds speed gradually and practically flares itself as front risers are smoothly released, leaving the pilot to slowly bring the toggles down to keep the canopy planing as it bleeds off speed. Not only does stabbing the toggles indicate the pilot was about to hit the ground hard, it deteriorates the overall landing. Why? Because toggles are also brakes. The less you use them, the further and faster you will be able to swoop. The longest, fastest canopy swoopers always use the least amount of toggle input!

Because of the lack of formal training for high performance landings, many skydivers have developed bad flying habits that put them in dangerous or inefficient situations without conferring any speed and performance benefits. For example, if too much front riser is pulled down, you deform the airfoil and reduce its efficiency. This will become obvious when you realize pulling the front risers down only affects the front area of the canopy. Seen from the side a canopy with too much front riser input appears to have a step in it, which means a perfectly good canopy has been deformed to the point where it no longer flies well. The classic manifestation of the trashed foil is a canopy that appears to be bucking, or lurching down a flight of stairs. In some situations (and only with some canopies!) this is actually useful, such as initial descent into a tight area like a clearing in the woods or a stadium. For landings, however, deep front risers need to be released early since they create lots of downward speed but not much lift.

Another common mistake in front riser approaches is to enter and exit the front riser maneuver suddenly. A sudden change of the surface configuration can disrupt the smoothness of the flow and cause a dramatic loss of lift! Suddenly dropping the front risers and then rapidly braking with toggles is a very inefficient way to flare, since both actions handicap the airfoil's lifting ability. Instead, a good front riser landing involves a gentle entry into front risers (never let go of your toggles!) that gradually steepens until the canopy achieves its fastest speed without major distortion of the wing. When the risers are smoothly let up, the canopy slows down and the pilot swings forward - the flare has begun before the toggles are even used. Then, the pilot maintains the high angle of attack by using toggle input to keep the flare going.

In any discussion of high performance landings the subject of riser verses toggle turns will come up. After years of watching a variety of techniques, I have concluded that front riser turns are far superior to toggle turns from a safety stand point. The reason is an extremely simple one. For a toggle turn to produce any speed to swoop with, it must be done as low as possible! Otherwise, it is just another high turn and all of the speed bleeds off well before the flare. A front riser turn, on the other hand, can intentionally be initiated too high, and then steepened or supplemented with the other front riser as needed. Therefore, a swooper using a front riser approach can always start at a conservative height while a toggle turn onto final compels the skydiver to turn as low as possible.

The implication of this goes further because of the way a canopy comes out of a turn. A front riser turn accelerates the canopy, while a toggle turn slows the canopy down. The difference is most noticeable at the end of the turn. Following a front riser maneuver, the canopy slows down to its normal speed and wants to come back over the pilot. After a toggle turn, the canopy must speed up, then there is a considerable delay before the pilot swings back under it. A toggle turn may create a bigger pendulum action for the suspended weight because the canopy can slow down much faster than the person under it, whereas in a riser turn the canopy accelerates only slightly faster than the pilot. In a toggle turn, the pilot must swing back under the parachute and the parachute must regain lost speed before it is controllable and generating maximum lift. A front riser turn is easily abandoned at any point, with full control of the canopy retained. Once a toggle turn is in effect, there is no escape.

A dramatic toggle turn also causes the wing loading of the canopy to change considerably - normal in flight, low as the canopy slows down and the weight reaches the height of its swing, then heavy as the weight swings back under the canopy. Whether or not these dynamic changes in wing loading make the canopy more vulnerable to turbulence than the fairly steady loading of a riser turn is open to debate.

An additional hazard with toggle turns can occur at very high wing loadings - perhaps 1.4 or higher, depending on the canopy. In a sharp enough turn, the pilot can swing out so far that as he swings back under the canopy, the induced weight overloads the canopy. In this situation the wing is essentially in a high speed stall - what pilots would call an accelerated stall. At this point the pilot has no control and even flaring may be useless. In fact, flaring might reduce lift even further. In any case, remember the apparent wind. If you are looking straight at the ground, flaring will only change your impact point.

However, this is not a blanket endorsement of front riser turns. There is a phenomenon that can take place in a high speed turn that can lead to complete collapse of the canopy, and in theory a canopy in a sudden front riser turn may be the most susceptible. Canopy collapse takes place when the apparent wind striking a canopy undergoes a sudden change, whether the cause be a change in angle of attack, angle of incidence, or some other factor - wake turbulence off another canopy, for example - causes the canopy to be "back winded," a term from sailing. When a foil is back winded, it means the apparent wind is striking the lifting surface of the foil instead of the leading edge. In the case of a canopy, this can drive the air out of the cells and collapse the

canopy. Canopies at particular risk are small, highly loaded canopies with a relatively flat trim angle and a relatively aft center of lift. Proponents of toggle turns argue that a front riser turn is more likely than a toggle turn to produce a canopy collapse, due to the changing angle of incidence. In the real world, the few catastrophic canopy collapses on record seem to be more a factor of design than of handling. There does not seem to be a correlation between front riser input and canopy collapse - at least none that I know of.

In summary, while both front riser turns and toggle turns create an increased descent rate and corresponding increase in speed, for intentional maneuvers a front riser turn is usually more desirable in that it offers more escapes in the event of a lapse of judgment or a sudden change in the environment.

Turns over 90 degrees carry an unacceptable degree of risk to other skydivers unless they are very carefully executed within an established pattern. It becomes very difficult to monitor traffic once you stray from the customary downwind, crosswind, final pattern. Equally important, it is difficult for traffic to monitor you! Downwind legs over the landing area followed by low 180s not only create tremendous changes in vertical and horizontal speeds but interfere with the traffic patterns already established by others. An additional consideration is that a turn over 90 degrees does not confer significant increases in speed but greatly increases the potential for mistakes, not just on the part of the person doing the hook turn. Some of the other parachutes on approach could be piloted by people who may not be able to avoid unusual wake turbulence or who might do their own low turn unintentionally in order to avoid the undisciplined canopy pilot. The same ethics apply to people on the ground. The whuffo being swooped could be deaf or unaware of how parachutes fly, and no skydiver likes to hear the whistle of wind through microline behind their back and wonder if they are the next innocent victim.

Referring again to practical tests with an airspeed indicator and variometer, modern canopies at 1.4 wing loadings typically fly at about 30 mph straight and level, toggles up. They can hit speeds of up to 50 mph coming out of a turn, and may be going 20 mph with the brakes still set for deployment. In descent rate modern canopies usually peg my variometer at its peak reading of 1600 feet per minute of descent, giving us a minimum downward component of 18 miles per hour. Since this instrument limit is hit long before the maneuver is completed, we can assume downward speeds of 20 to 30 mph are routine when deep in a turn. Older, lightly loaded designs are significantly slower. Thus, it is the combination of a fast canopy, high wing loading and a turning maneuver that creates the greatest energy.

Besides the amount of kinetic energy delivered by fast canopies, there is the time factor. I prefer to use feet per second instead of miles per hour, since skydivers work in feet and seconds, not miles and hours. Twenty miles per hour is roughly 30 feet per second. Thirty miles per hour is roughly 45 feet per second, and fifty miles per hour is about 75 feet per second. Regardless of how fast the canopy flies, human reaction time is about one quarter of a second to merely recognize a problem. In a complex emergency situation, we can assume that an alert individual will require a quarter second to recognize a problem and no less than the remainder of a second to implement a response.

A second is more than enough time to resolve a simple emergency - pulling your hand away from a hot stove, for example - but is it enough time to recognize, assess and resolve a potential canopy collision? I think not, since the pilot must not only avoid the collision but do it in such a way that he does not create an equally serious secondary emergency, such as a different collision.

The illustration shows [webmaster's note: we're still working on the illustrations] two canopies on a collision course at ninety degrees to one another. We can see that in situation a) the canopies are one second from a collision when they are 42.4 feet apart. If we speed the canopies up, that one second remains constant as the distance expands. In situation C, the canopies are one second from collision when they are just over one hundred feet apart.

Now imagine that these scenarios are transpiring not on a blank sheet of paper but in a crowded sky fifty feet above the ground. Add a couple buildings and some power lines to the landing area to dramatically curtail the options. The point? We must assume a single second is not enough time to adequately respond to this complex emergency. That means to have any kind of safety margin - let's say three seconds - the canopy pilots in situation C must know the position, current direction and the intent of every canopy within three hundred feet.

In a similar situation, let's substitute a running child (12 feet per second) for one of the canopies. If the child darts out in front of the swooper (canopy C) with only 40 feet of horizontal separation, we have a dead child on our hands.

Using the same scenarios and assuming a collision at the end, let's look at the kinetic energy involved. For simplicity we will assume that the skydivers involved both weigh 170 pounds. Using mass times velocity squared to determine the energy going into the collision, we find each skydiver in a) enters the game with 153,000 foot-pounds of energy, for a total collision force of 306,000. Moving to scene c) we come up with 956,250 per skydiver and 1,912,500 total points in the collision.

Substitute a seventy pound child at 12 feet per second for one of the canopies, and you find the child enters collision a) with a mere 10,080 points versus the skydiver with 153,000. In c) the difference is even more spectacular: 10,080 vs. 956,250.

Thus we see that speed, more than any other factor, drives up risk by increasing collision forces and reducing the time and space in which we act. An interesting corollary develops with fast canopies; piloting them to a safe landing can demand so much focus that other important factors might be neglected. For example, if you need to devote all of your concentration to your canopy handling in order to land well, you have nothing left for traffic management. Conversely, if a traffic problem suddenly arises you may not have enough attention left to land your own parachute well. In a crowded landing area with canopies of varying speeds you need to devote quite a bit of concentration to the other canopies. If your own parachute demands all of your attention, you cannot safely land around others.

TEACHING CANOPY PILOTING TO OTHERS

Guidelines for Instructors

The Instructor

When I began learning freefall technique in 1980, there was no real body of instructional knowledge on how to teach freefall. Each person had their own way of communicating technique, and in fact even actual technique varied considerably. Half a generation later we have AFF, Skydive U, and other teaching standards. Everyone knows what a box man is. Coordinated turns, exit positions, vertical and horizontal control - all these things that were obscure and arcane subjects in 1980 are now well understood and easily taught. Nothing about the air or our bodies really changed; it was a change in thinking. Freefall skills went from being some mysterious ability to being simple techniques that anyone could learn and most people could learn to teach.

Canopy flying today is where we were in freefall when AFF came along. Many of the finest canopy pilots I know could not describe what their parachute does, or their technique to put it where they want it, if their life depended on it. They learned through trial and error over thousands of jumps. But just as what I learned about freefall in a thousand jumps I could now teach someone in 250, what I learned about canopies in 3,000 jumps I can teach to someone in 500. But it doesn't really matter what I can teach: I can only reach a few dozen, at most a few hundred people. A teaching method that can be used by any mentor, any drop zone, is far superior. I have tried to formulate the text with that idea in mind. The next step is for you, the instructor, to put the information out in a useful context.

Before we go further, however, let's ask an important question. Who is capable of instructing someone on canopy control? To be blunt, I would say that more than half of the AFF Instructors I have met do not have the necessary knowledge. I personally don't feel someone should present themselves as a competent canopy pilot unless they have at least fifty CRW jumps, competition accuracy experience, and a number of demo jumps under their belt. Although CRW canopies are very different from RW canopies, CRW is without a doubt the best all around teacher of canopy skills there is and anyone who hasn't done enough to at least dock fourth is under qualified to be a canopy flight instructor. True, we aren't teaching a CRW course here. But to really understand how canopies sink and float, fly in turbulence and deploy you need some serious CRW experience. It is also invaluable for canopy collisions.

You should also have several hundred "hook turns" in your log. Regardless of how you or your dz feels about hook turns people want to know about this technique. If you can't do it safely, you can't teach it. Before you answer "yeah, I can swoop with the best of 'em," ask yourself this: Have often do you use your brakes to pull out of your dive? If you use your brakes very often (more than once every fifty or so swoops?) you don't have the skill. Do you use more than a 180 turn? If so, you don't have the judgment.

It might seem to some that my standards are too high. After all, you might say, "I don't need to be a national champion to teach RW." No doubt some individuals will be exceptions, but my point is that most so called expert skydivers have extremely limited canopy experience and don't realize how little they know. If you haven't done a fair amount of CRW, you don't know much about canopies, period.

Go get the experience; learning to learn again will make you a better teacher. If you don't know how to swoop a modern canopy, you won't have any credibility with that very large segment of our audience that wants to learn. Try it - you might like it. Finally, someone is bound to have a big, slow demo type canopy. You need enough accuracy skill to guide them on approach planning and inform them on how to fit in with other canopy types in the traffic pattern.

Other than the canopy handling skills, the course instructor needs two teaching skills: assessment of performance and ability to communicate. A good grasp of the materials and flying skills won't be any help if you don't have the ability to watch a landing and critique it effectively. To practice this, just watch a lot of landings with a critical eye. What distinguishes a "good" flight from a "bad" one? What would you have done differently?

Class Size and Management

To test my theories I ran three "canopy camps" in 1996. The camps were one day affairs. Students signed up in advance, with a ten dollar down payment to cover the cost of the written materials they were expected to study before arriving and to confirm their reservation. To qualify they needed at least fifty jumps and their own gear, with a minimum of twenty jumps on the canopy they were using. The day's structure was simple, and it was effective enough that I didn't make any significant changes between courses. We met at nine a.m., at which time I would get everyone's name, number of jumps, canopy type, wing loading, and general goals. All the camps were about evenly split between conservative canopy fliers seeking better accuracy and traffic skills and aggressive younger fliers interested in learning how to swoop, or planning to move to a smaller canopy.

The fee for the one day course was \$60.00. This included six jumps from 3,500 feet, video of each landing, course materials, and classroom instruction/video debriefs. I paid the drop zone \$6 per jump; that left \$24 per person to pay the video man, the copy shop, and myself. With six students I could figure on making about \$100 for a day's work. Not a princely sum, but enough to give an instructor an incentive to take a day off from other teaching duties. People motivated primarily by money would want to charge a little more if class size is small. I don't want to sound cynical here, but I understand the financial reality of choosing between doing six tandems or teaching a canopy class.

Regarding class size, at a Cessna dz a class of four would be ideal. I am from an Otter dz and I didn't want to load the plane up with a lot of people going out low, so I limited it to six. More than that requires a second load (which would really slow things down) and clutters up the sky with too many students. The students need a little traffic to sort out, but not too much. I believe that four or five is the optimum class size. Larger groups are also unwieldy in time. It takes everyone longer to pack, get manifested, sit through the briefings, etc.

For optimum efficiency, stick to four or five and have them all exit on the same pass. This keeps the class moving as a group. If drop zone logistics don't permit moving as a group you will have to be creative, but it really helps to debrief as a group since so many common errors will be shared by more than one participant. As soon as they land, they should get packed while you review the video in private and note what you will cover in the debrief. Give them about 20 minutes to pack and grab a snack or drink before meeting again. Be sure they know when they are expected and emphasize that they are part of a group; being late or unprepared is unacceptable behavior.

We met for a debrief after every jump as soon as the group was packed. I did my best to point out things that everyone could learn from. Be sure to emphasize positives more than negatives, but don't hesitate to be firm about any dangerous behavior. I found I needed to allow about twenty minutes to review and debrief the prior jump and another twenty to thirty to present the next segment of material and brief the group for the next jump. If there is any back up at the manifest, be sure to manifest while you are still in class to avoid idle time waiting for a plane.

I feel strongly that the jumps should be done from 3,500 and dedicated strictly to canopy flying. Doing canopy instruction after RW would involve too many distractions. The 3,500 exit really focuses people on the task at hand, which includes spotting and deployment as well as piloting the open canopy. With four to six people getting out on the same pass they have a little traffic management to work on, but not so much that it distracts from the landing portion. It is also an economical altitude and keeps the pace moving quickly. My classes always went until six or seven in the evening - there is that much to cover once you get into detailed analysis.

Of course, after the last jump a debrief over cold beer is the natural course. Most of the class will feel they have really learned something. This is a great time to reinforce their enthusiasm for improving flying skills.

Another important point is the video. On a few landings I tried to shoot the video myself, but it is much more effective to get someone else to do it while the instructor stands by with a note book to record what takes place. A video doesn't show the ground reference until the canopy is quite low, so you need to take careful notes about what they do while setting up the approach. Furthermore, it helps the video recorder to have the instructor help spot canopies since they will all be landing in the space of a couple minutes. You will soon learn that vertical traffic separation is as crucial to you as it is to the student; they need it for an unimpeded approach and you need it so you can concentrate on individuals one at a time.

The first jump of the course was always the same. I asked each student to do what they would normally do, aiming at the pea gravel to establish a yardstick of precision landing skill. Once they were down, a brief critique would pick out one or two points for them to concentrate on. As the course progressed the individual students would become differentiated: some would need lots of focus on their set up, some on the flare timing, etc. In any teaching effort it is useless to try and note every possible area of improvement. One or two major things will stand out. Focus on no more than three areas of improvement.

I found it easiest to have a theoretical outline I would cover in class between jumps, and then a particular set of tasks on the jumps themselves to reinforce basics.

Classroom Syllabus

Section I: Introduction to the course, evaluation, and goals. Prior to the first jump.

- 1) General discussion of common problems/accidents associated with canopies; the reason we are doing this course.
 - a) Deployment collisions and malfunctions
 - b) Approach collisions with other canopies
 - c) Collisions with the ground or obstacles
 - d) Collisions with people on the ground
- 2) General overview of parachute design and flight characteristics. Discuss lift and drag, fluid flow, turbulence, and flow separation. Differences between main and reserve, and what to expect. Special reserve considerations: rounds, old five cells.
- 3) Basic canopy safety
 - a) control of deployment: packing, body position, separation.
 - b) visual assessment of altitude; emergency procedures
 - c) malfunction related problems (hard cutaway, self induced mals, etc.)
 - d) collision avoidance control
 - e) traffic management - vertical and horizontal space, assisting others to a safe approach. Patterns left most of the time, responsibilities of right patterns, sharing the landing area.

Section II: Improving your canopy flying. Discussed between the next three jumps.

- 1) Discussion of canopy control input
 - a) normal toggle input
 - b) front and rear risers
 - c) deep brakes
 - d) flat turns in brakes
 - e) minimum and maximum sink rates
 - f) tuning your canopy to maximum efficiency: blocks and loops, pilot chutes, sliders, etc.
- 2) Conventional approach - downwind, crosswind, final. Patterns, why no S turns or brakes.
- 3) Performance approach

- a) straight front riser
- b) front riser turn to final

Section III. Canopy Safety: after a three or four jumps.

- 1) *Unusual landing situations*
 - a) *tight landing areas*
 - b) *cross wind landings*
- 2) *Problems specific to our drop zone*
 - a) *obstacles with different wind directions*
 - b) *traffic*
 - c) *density altitude*
 - d) *turbulence from thermals, wings, aircraft engines, the hangar*
- 3) *Problems associated with out landings*
 - a) *causes of out landings - reserve ride (etiquette review), bad spot, etc.*
 - b) *hazards, light and wind assessment*
- 4) *Winds*
 - a) *short, long, and off the line - tricks to get you home*
 - b) *special approach for windy days - no 360s, never get behind the landing area*
 - c) *flare for windy conditions*

Section IV: Ethics and Aesthetics. At the end.

- 1) *develop a thoughtful pattern that gives the most options to you and to everyone else.*
- 2) *if you want to fly like a student, go to the student area! Do not use brakes, 360s, or S turns in the landing area.*
- 3) *clear the area at once, don't run with an open canopy. Reasons not to debrief or chat in the landing area. Particular traffic danger zones: peas, fence. You aren't safe until you are out of the landing area!*

Jump Schedule

Lesson 1: One jump

Focus on clean deployments, have them play with body steering, both riser groups, toggles. Flat turns. Discuss riser blocks and loops. First jump will be an evaluation, so no special approaches, just try and put it in the peas using your normal approach.

Lesson 2: Three jumps

Based on the performance in jump one, discuss traffic management and approach patterns. Give each a goal based on previous demonstrated ability. Have them track on opposite 90 headings prior to deployment, stage openings, etc.

Lesson 3: One jump - set up crosswind landing with cones if conditions permit

Further individual instruction, review mals and collision procedures. Lengthy talk on separation, tracking technique, and wave offs. Two most critical decision making areas of the skydive are breakoff/deployment and the landing.

Final jump, class wrap up

Continued individual assessment and challenge. Reserve characteristics.

Some of the things covered in the camp are items that many people have never had presented to them before. Give them challenges. For example, I always try and get people to check altitude visually on the ride up and the ride down. Teach them to play a game with themselves where, without looking at their altimeter, they glance out the window (or at the ground when under canopy) and ask themselves if they are high enough to cut away, what the exact altitude is, whether they could make a certain field from where they are, etc.

My class of six was a little perplexed when I told them on the second jump that I wanted them all out of the Otter in ten seconds, leaving from 3,500. On the first load they had each waited in the door for five seconds or so prior to a hop and pop. Without guiding them too much, I pointed out that 3,500 was a typical break off altitude, and they had plenty of time to track off the line of flight, stagger openings, etc. They soon learned to take advantage of the 1,500 feet of potential freefall altitude, combined with varying descent rates, to give themselves plenty of separation for deployment and landing approaches.

Another challenge is to restrict a certain portion of airspace; "on this jump you may not overfly such and such an area." Add imaginary lakes, power lines, or buildings to your landing area. If the winds are light, make them land cross wind if a safe opportunity to do so exists.

In conclusion, what has been done so far has been simple, early experimentation. There is lots of room for improvement and innovation. I look forward to hearing from instructors or students who have insights, suggestions, or other information to share. Please feel free to contact me at

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